HANDICRAFT IN THE SCHOOL

GENERAL ARRANGEMENT OF SUBJECTS

VOLUME I

Easy Handwork for Infants. Editorially Contributed.

Introductory (Colour, &c.)—Mat Plaiting—Weaving—Handwork with Pegs, &c.—Stick Laying—Unravelling—Worsted Dolls—Simple Toy Making—String Work (including "How to Tie a Parcel")—Maize-seed Beads—Handkerchief Folding—Paper Folding and Cutting—Paper Flowers—The Magic Folds—Miscellaneous Folding and Cutting.

Raffia Work. MISS M. P. GOTT.

Materials—Preparation of Raffia—Winding—Plaiting or Braiding—Weaving—Toy Making—Coil Weaving—Stitches of Indian Basketry—Dyeing—Sewing on Linen or Canvas with Raffia.

Educational Handwork. J. L. MARTIN, Headmaster of Adcroft School, Trowbridge; and C. V. MANLEY, Headmaster of Mortlake Church of England School, London.

Paper Folding and Cutting Exercises—Systematic Courses leading to Geometry and Constructional Cardboard Modelling, &c.—Communal Work—Plastic Work—Wire Work—Iron Work.

Stencilling. C. V. MANLEY, Headmaster of Mortlake Church of England School, London.

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Sand Modelling. F. W. FARRINGTON, Headmaster, the Medburn London County Council School.

A stepping-stone to the more advanced lessons on Clay Modelling which follow.

Clay Modelling in Manual Training. F. W. FARRINGTON, Headmaster, the Medburn London County Council School.

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General Arrangement of Subjects

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Educational Woodwork. A. W. MILTON, Examiner in Manual Training, Education Department, Transvaal.

Principles and Practice—Class Management—Drawing Instruments and Their Use—Tools and Their Use—Practical Work, &c.

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VOLUME I

Easy Handwork for Infants

By SUNDRY WRITERS

Raffia Work

MISS M. P. GOTT

Educational Handwork

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PREFACE

This volume of HANDICRAFT IN THE SCHOOL covers a wide range of subjects suitable for pupils from Infant Room to Upper School.

In its first section there is grouped together a collection of Infant-Room Occupations, some old, some new. It has been the purpose of the editors, while presenting in the work the most advanced development in School Handwork, not to allow the old accepted Occupations to be lost sight of. The old is constantly becoming new again, and it is believed that teachers will find in the first section of the volume much which, if well known in some quarters, will be new in others.

The second section, "RAFFIA WORK", takes up this most useful and interesting occupation in all its phases. The endeavour has been to help the demonstration of methods of procedure by copious illustration, and it is believed that, with the instruction here given, RAFFIA as a handwork may be effectively taught in any school.

The third section, "EDUCATIONAL HANDWORK", covers a wide range of subjects, beginning with simple paper and cardboard folding and cutting, and proceeding by easy stages to the application of the facts learned from these exercises as the foundation for elementary geometrical study on the one hand, and on the other as the basis of exercises in Plastic Handicraft, Iron and Wire Work, &c. The chapter on "COMMUNAL WORK" presents many most interesting developments that cannot fail to prove both useful and attractive.

The section on "STENCILLING", based on the previous instruction, gives details of how to proceed towards developing skill in this highly interesting artistic handicraft.

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VOLUME I

Easy Handwork for Infants

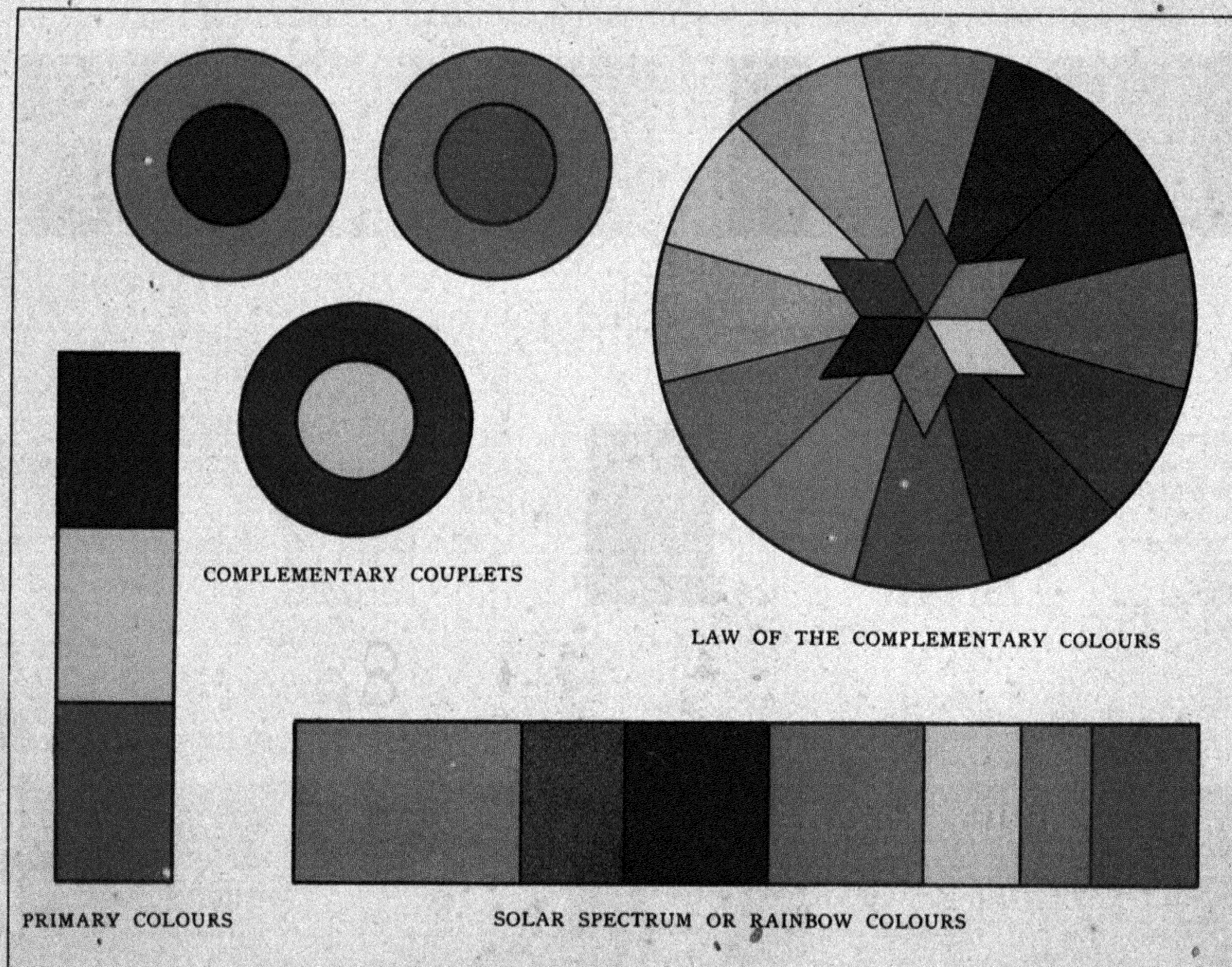
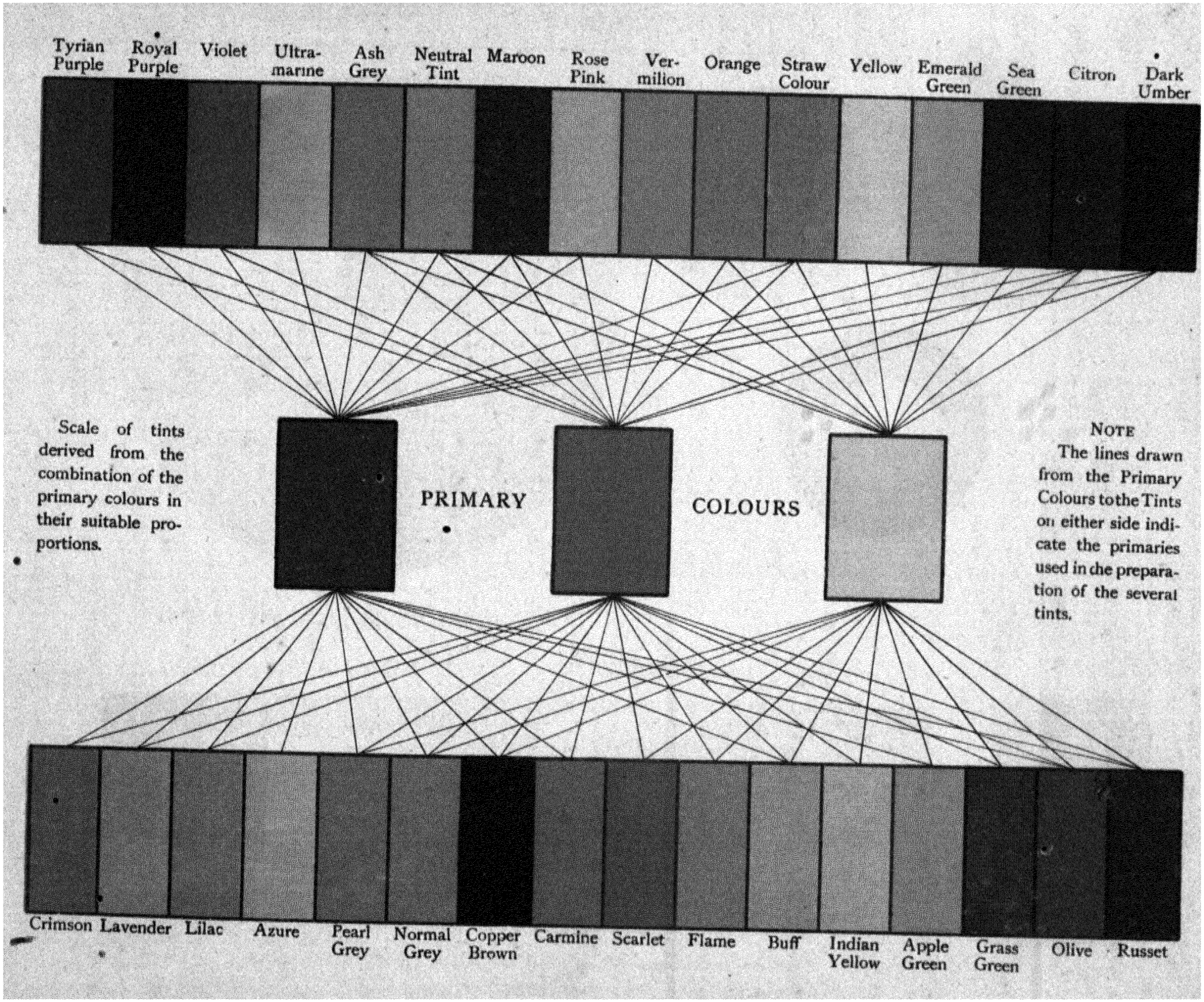


DIAGRAM ILLUSTRATING THE PRIMARY SOLAR SPECTRUM OR RAINBOW COLOURS
AND LAW OF THE COMPLEMENTARY COLOURS


Tyrian Purple
Royal Purple
Violet
Ultra-marine
Ash Grey
Neutral Tint
Maroon
Rose Pink
Ver-milion
Orange
Straw Colour
Yellow
Emerald Green
Sea Green
Citron
Dark Umber
Scale of tints derived from the combination of the primary colours in their suitable proportions.
PRIMARY COLOURS
NOTE
The lines drawn from the Primary Colours to the Tints on either side indicate the primaries used in the preparation of the several tints.
Crimson
Lavender
Lilac
Azure
Pearl Grey
Normal Grey
Copper Brown
Carmine
Scarlet
Flame
Buff
Indian Yellow
Apple Green
Grass Green
Olive
Russet

EASY HANDWORK FOR INFANTS

INTRODUCTORY: ON COLOUR AND OTHER THINGS

The following notes and illustrations of handwork suitable for infants are put forward as *suggestive*. They are capable of indefinite variation, at the fancy of the teacher. Not much detailed instruction is necessary; for the most part the illustrations are in themselves sufficiently explanatory. The wise teacher will know that to follow any fixed mechanical method is not good; for, as experimental research and the experience of Dr. Montessori have shown, children, while guided gently, should be largely left to develop their native inventiveness. The exercises provide a wide selection from which the teacher may choose and adapt and adjust to her own purposes.

In connection with *Weaving* and other exercises much can be done to develop the colour sense. The following notes on colour, and study of the accompanying Plate, will be useful to the teacher.

Gradation of Colours.—From the three primary colours, *yellow*, *red*, and *blue*, all others are obtained. By the simple mixture of any two of them the secondary colours are produced—green from yellow and blue, orange from yellow and red, purple from blue and red. These, again, supply another series—the tertiaries: citrine being the result of mixing orange and green; russet, of orange and purple; olive, of purple and green. From citrine, russet, and olive an endless variety of beautiful tints is obtained, varying as any particular colour predominates, and it is from these that the best colour schemes are usually selected. Some of the loveliest colours are so subtle in tint that it is difficult to name them or say what is the prevailing hue.

Properties of Colours.—Colours have definite properties, and convey to the mind certain impressions. For example, the warm colours yellow and red produce a lively, cheerful feeling, while the colder colours, blue, purple, and some greens, have the opposite effect. Again, yellows seem to be nearer the eye than they actually are, blues to be farther away, reds to

be stationary. Yellow appears lighter, blue darker, red brighter by gaslight than by day.

When a colour has been looked at for a time it seems to change, some other taking its place. This other is the colour, or combination of colours, necessary to make up the primary set of three. Thus orange after a time gradually passes into a bluish hue, blue being its complementary colour. Again, red looked at for a time seems to be obscured by a greenish hue; and so on.

Harmony of Colours.—As a rule, to obtain the fullest pleasure, the eye demands the presence of all the primaries, and this is possibly why the tertiaries are the most pleasing colours. That all three primaries should be present for the best effect is, however, by no means a hard-and-fast rule; in some cases the charm of the colourings lies in the absence of one of them. In colour work the production of proper harmony depends largely on individual feeling or instinct. No cast-iron law can be laid down.

It should be remembered that a colour merely contrasted with its complementary—for instance, red with green—will not necessarily harmonize with it. For harmony there should be judicious blending of the contrasting colour; the red should contain some green and the green some red in its composition, the exact proportions being a matter of practical experiment. As the yellows, reds, and blue greys of the citrines, russets, and olives contain blendings of all the colours, they give harmonious results more readily than the others.

Suppose it is desired to contrast a russet—which is a grey with a reddish tendency, for it receives red from both the orange and the purple of which it is composed—the colour to go with red is green, but the green employed must partake of the redness of the russet, and if the latter is very low-toned, so must be the former. Again, the proper green to harmonize with a red having an orange tendency—that is, one with yellow in it—is a bluish green, blue being the remaining primary. In the case of a red having a purple tendency—that is, one with blue in it—the proper green to harmonize is a yellowish green, yellow being the remaining primary; and so on with all other colours. The last two examples will be found useful in the selection of harmonious colours.

In decoration, sometimes a pure colour without admixture is advisable, and even necessary to true harmony, to give bright colour in a decorative scheme; but generally the primaries are to be avoided.

For the practical purposes of painting, colour printing, and decorative work generally, *red*, *blue*, and *yellow*, as stated above, are regarded as primary colours, though from a strictly scientific point of view yellow is not held to be a primary, a yellow ray of light being resolvable into red and green. Still, in practical affairs we deal with *pigments*, not with rays of

light, and as yellow and blue *pigments*, mixed, always produce green, and as no mixing of pigments will produce yellow, it is convenient to regard yellow as a primary colour.

The chief distinguishable colours of the **solar spectrum** (produced by breaking up white light by means of a prism into its constituent rays) are *red*, *orange*, *yellow*, *green*, *blue*, *indigo*, *violet*. (See Plate.) Of these the strictly primary rays, i.e. those that cannot be resolved into others, are the red, green, and violet rays.

The colours of the solar spectrum may be recombined so as to make white light. (See Plate.) Let a disk be painted as nearly as possible with the colours of the spectrum in sectors of the magnitude indicated in the diagram. If this painted circle be made to whirl rapidly round its centre, all the colours will be seen practically simultaneously, owing to the persistence of impressions on the retina of the eye, and the effect is that the circle appears white. If the proportions of the coloured sectors be altered, or if any of them be cut out or covered with white or black paper, various colours or shades of colour are producible on whirling. If one complete sector be removed, and the card whirled round, the colour produced is the one complementary to the removed sector.

WEAVING

MAT PLAITING

Weaving in essence is a very simple operation. Take four slips of paper about 1 inch wide and 10 inches long. Number them 1, 2, 3, 4, and allow the first two to lie in the same direction, and the other two to be placed across at right angles to them. Place No. 3 *over* 1 and under 2, and No. 4 *under* 1 and over 2.

We have here the beginning of a woven fabric. There are two sets of papers, which we might compare with woollen, cotton, or any other threads, and these two sets help to cover each other and to bind or sustain each other. By this plan all the four strips have a grip on each other. One set is quite as much needed as

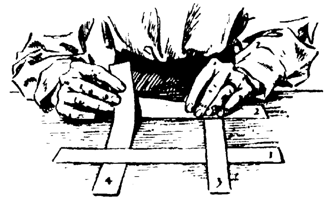


Fig. 1

the other; take away any single strip, and the whole is spoiled.

In all woven cloth the threads are so arranged that they interlace each other and sustain and cover each other.

MAT PLAITING, a form of weaving, is most interesting to little children, and cultivates the sense of colour as well as the training of the hand to nicety of touch. Raffia work is in some of its features an extension of the same thing with a different material.

Materials (see Plate).—Sheets of paper cut in the manner shown in the accompanying diagrams, loose strips of paper for weaving in, wooden or steel braiding needles, the latter much longer than the former.

As the slats in the sheets and the separate strips must be perfectly even, it may not be practicable for the teacher to prepare these herself; they can be procured from one of the scholastic firms.

Commence plaiting by lifting up the first slat, then the third, then the fifth, then the seventh, and so on until the loose strip has been interwoven. Observe that the two loose ends of the strip are on the under side of the mat.

Take a second loose strip, thread it, and commence to plait another row. In weaving in the strip to form the second row, observe to pass the needle over the first slat, then under the second, over the third, and under the fourth, and so on until the strip has been woven in.

Push up the second slip so that it may lie close to the first. Cut off the ends of the strips which have been interlaced and gum over them a piece of clean white paper. The whole of the back may then be covered with paper, and the edges ornamented with a narrow fringe of white or coloured tissue paper.

As the children advance in skill, more difficult patterns may be made and a greater number of colours used. See introductory remarks on *Colour*.

It will be evident that patterns may be varied almost indefinitely. When completed the mats can be adapted for many purposes useful and ornamental. Thus fringed with tissue paper they make pretty mats for flower vases; without fringes they may be used to cover boxes; edged with brown paper or thin leather they can be used in many ways.

A few patterns are here illustrated to show the varied forms which may be produced by using slips of different widths and colours.

THE WEAVING OF CLOTH

The work already done prepares the way for understanding the weaving of cloth in a simple loom. Some account of this will now be given.

Structure of Cloth.—Let us pull to pieces a bit of common woollen cloth. From the edge we can soon draw out a thread running the whole length of the piece. A second thread,

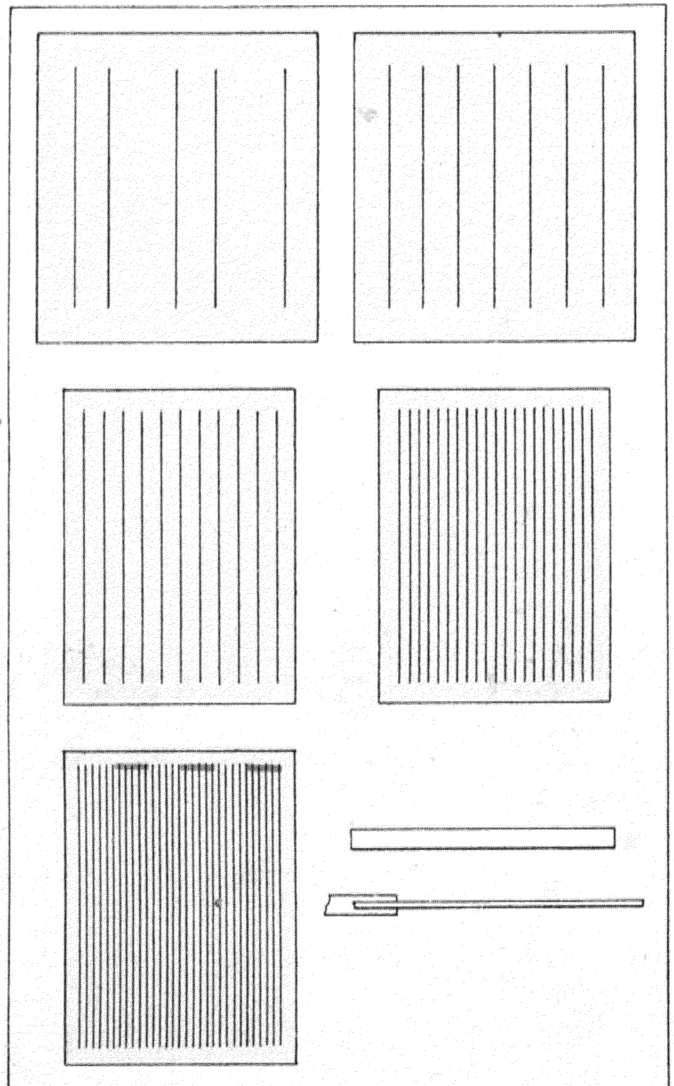
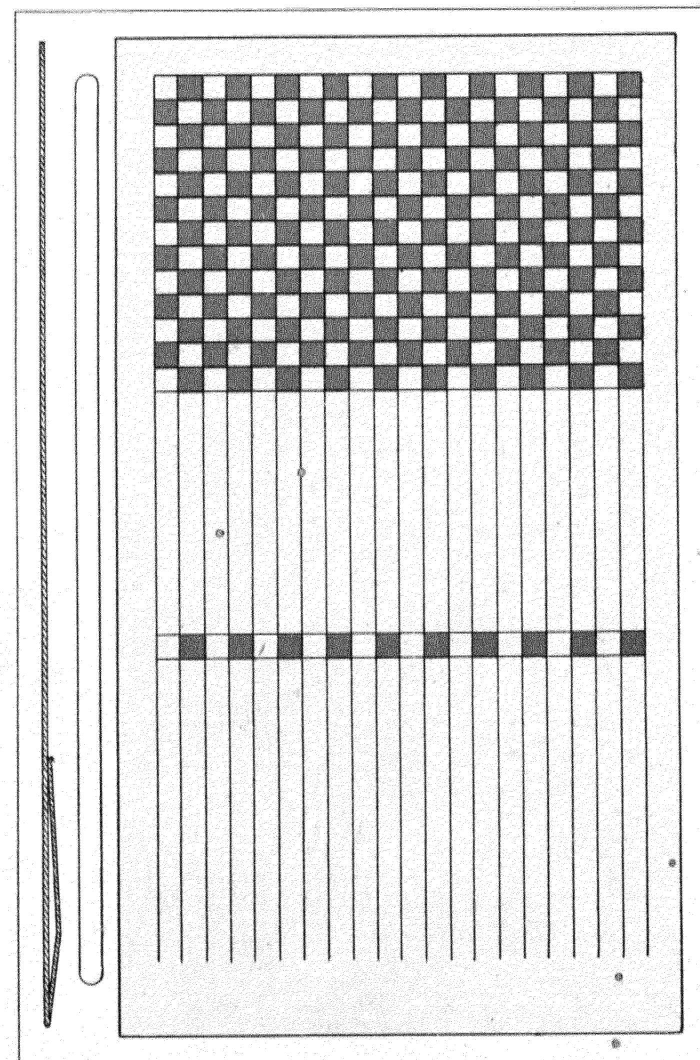


PLATE 24



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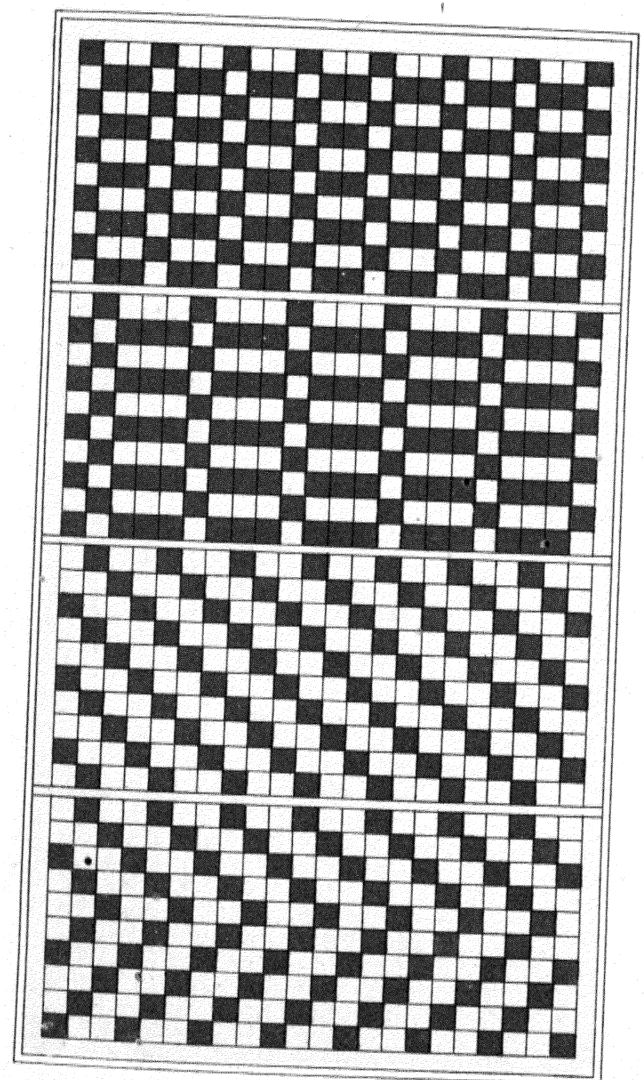


Plate 26

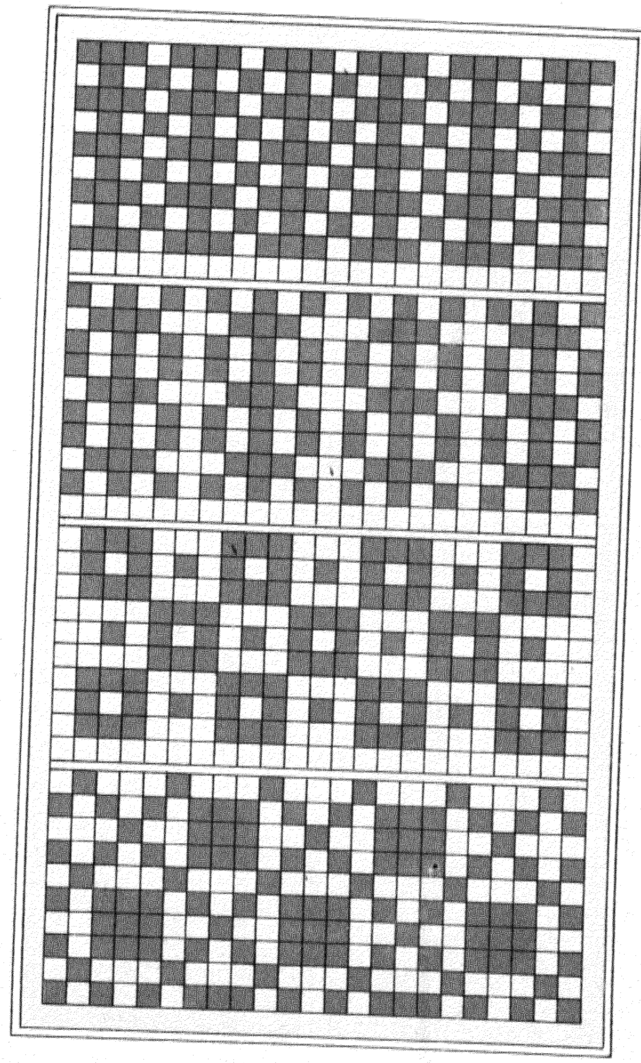


Plate 27

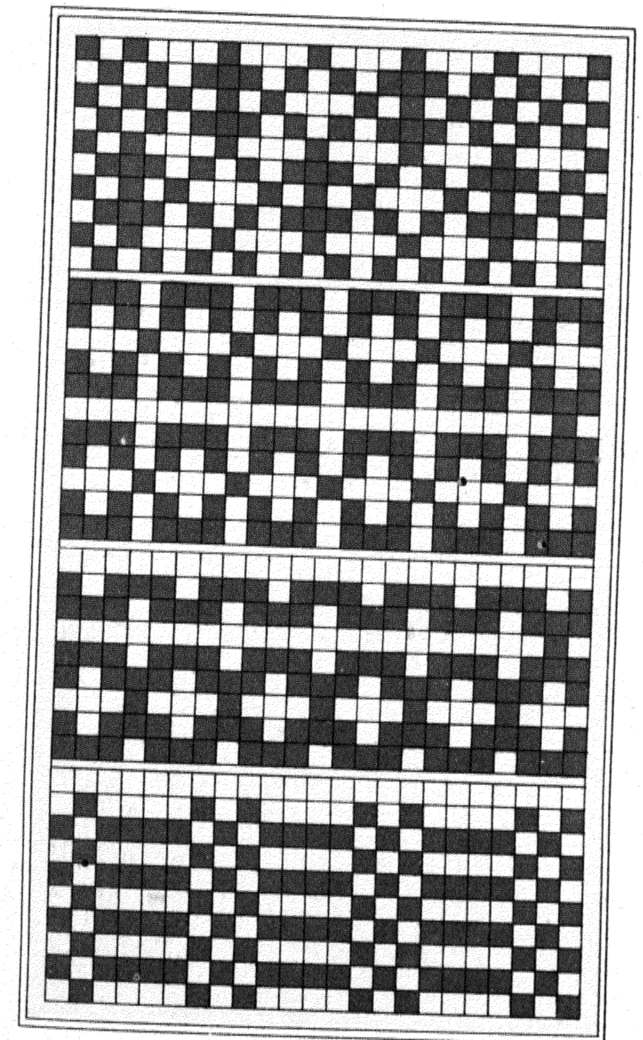


PLATE 28

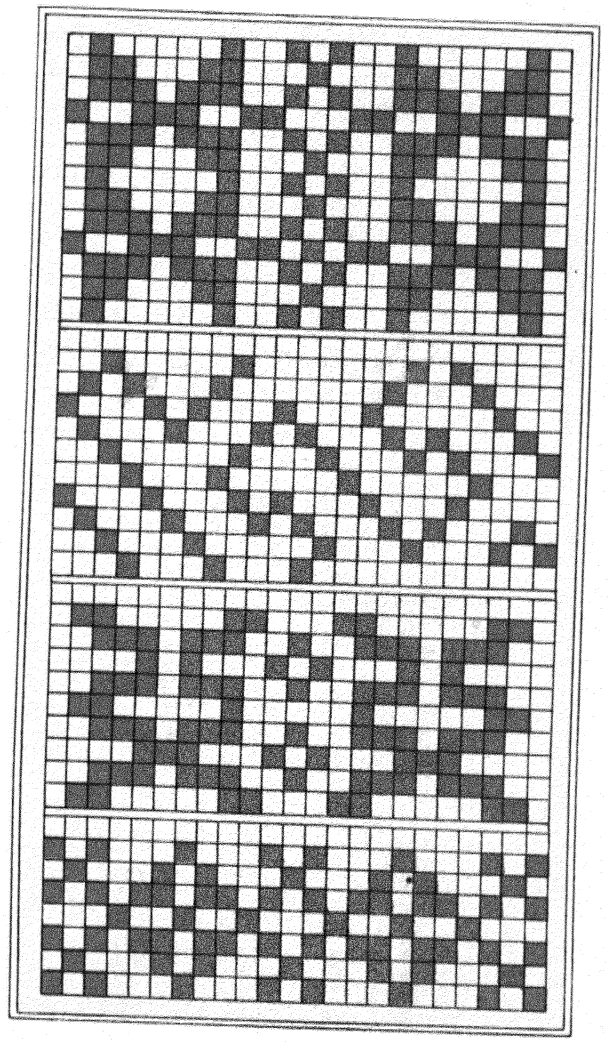


PLATE 29

lying the same way as the first, can next be pulled away; and so on. We soon see that there are other threads arranged at right angles to those we have been taking out of the pattern. The long threads first mentioned are known as *warp*, and the shorter cross threads are called *weft*.

If we look carefully, we shall find that a weft thread passes *above* one of the warp threads, *under* the next one, *above* the one after that, and so on alternately, right across the cloth. The threads are woven so very close that we cannot see between them with the naked eye, and they help to bind one another into a solid whole. This is just what the strips of paper did.

Structure of a Hamper.—The essential structure of a woven fabric may be further illustrated

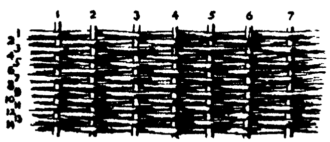


Fig. 1.—The Construction of a Common Hamper

on a larger scale by examining the side of a common hamper or basket. The skeleton of the hamper is first made of a number of upright sticks placed at equal distances apart. Across these sticks osier rods are woven out and in, one above the other, in a regular manner. Rod No. 1 is placed in front of stick No. 1, then passed behind stick No. 2, then back round the front of stick No. 3, behind No. 4, and so on alternately. Rod No. 2, placed close to No. 1, is twisted about the sticks in the same manner, but it is passed in front of those sticks that rod No. 1 went behind, and behind those that rod No. 1 passed in front of. The basket would fall to pieces if either the rods or the sticks were removed.

The Parts of a Loom.—The essential parts of a loom are the following: the *warp beam*, a wooden roller with axles in its ends, from which the warp threads are rolled off in weaving; the *cloth beam*, a similar wooden roller at the other end of the loom, which receives the web of cloth as it is woven; and the *shuttle*, by means of which the weft threads are intertwined with the warp across the loom. The warp threads, which are usually much finer and firmer than the weft threads, are tightly strained in order to let the weft threads be passed easily over and under them. The weft threads are soft and yielding, so that the weaver can beat them well down into a good, solid fabric.

Shedding the Warp.—If we watch a basket maker at work we shall see that he threads the thin willow rods round the sticks laboriously by hand, first over one, then under the next, and so on. The early weavers must have made cloth in that way also, but the process was very slow; and very early a simple device for saving

time was discovered by some thoughtful weaver. This weaver saw that if the warp threads that the weft was to pass *under* could be raised above the others, the weft thread could be passed through the opening or *shed* thus made, and in this way the whole thing would be accomplished

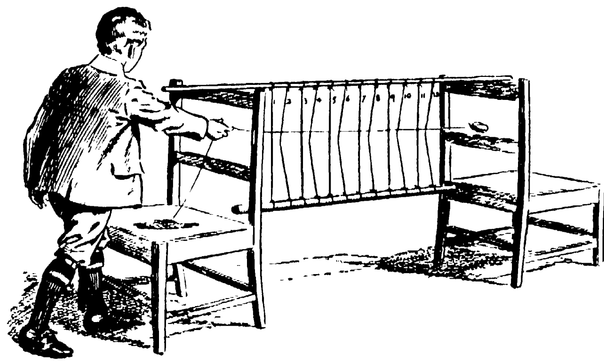


Fig. 3

at a single stroke. If the threads of the warp that were down could now be all raised, and the others all lowered, the next weft thread could be shot through the new shed so as to be exactly right.

You can illustrate this very simply by taking a dozen strings and tying them to a stick slung across the backs of two chairs. The lower ends of the strings could be tied to a heavy piece of wood, which would keep them upright and taut. Number the strings from 1 to 12. Suppose, now, that all the even strings are pulled back. Then there would be a kind of lane between the two sets of strings; this represents the *shed* in warp. If you have a ball of string with a stone or piece of wood attached to the free end, it is easy to jerk the stone or wood through the passage between the two sets of strings. This is essentially weaving. (See fig. 3.)

Method of Shedding Warp.—To make the shed the early weaver slung his warp flat, like the top of a table, and fixed a cord to every thread. The cords attached to one set of alternate threads were drawn all down together by a pull with the foot; and the cords attached to the other set of alternate threads were similarly joined for simultaneous depression. The odd and the even sets of warp threads were depressed alternately, while a weft thread was shot through the shed thus made.

Healds.—As time went on, the weaver found other means of shedding the warp. We can well imagine the discomfort of the early weaver who had to use his big toe in pulling down the looped cord. A great improvement was made by fastening the warp-drawing cords to a pair of wooden slats; the loop on each cord was made in the middle of its length between the slats; the pair of sets of cords became what is now known as the *heald*. In time the cords and their loops were replaced by thin wires having

eyelet holes or rings in them, through which the threads were passed. These wires were fixed in wooden slats, which could be raised or lowered by the treadle beneath.

The Shuttle.—The shuttle for carrying the weft is made of hard wood, and is shaped like

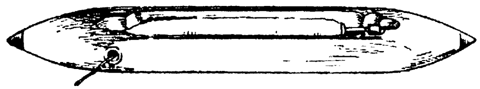


Fig. 4.—A Shuttle

a boat. At its tip there is a smooth iron point. The whole inside is scooped out, forming a kind of cone, and at the base of the cone a screw or pin is fixed to hold the boobin or spool. Near the top of the cone a small hole is drilled through the wall of the shuttle, by which the thread can pass out. To load the shuttle the weaver takes a bobbin full of weft thread, fastens it by the screw, leads the loose thread along to the hole, and draws it through with his breath.

The Working of the Loom.—The diagram shows the chief parts of a simple hand loom, and the method of working it. A is the warp beam, on which the threads are wound. B is the cloth beam, on which the cloth is wound as it is made. C, C are the healds for shedding the warp. The healds are connected by ropes passing over the log E, and when one is raised the other is lowered. D is the shuttle.

To work this simple loom the weaver first passes the first warp thread through the first hole in one of the healds. The second thread is passed through the first hole in the other heald, and so on, alternate threads being passed through alternate healds. When the weaver depresses one of the treadles the heald to which this treadle is fastened is pulled down, and of course one set of warp threads comes down with it. Through the shed thus formed the shuttle, holding the weft, is passed and a length of thread is left behind. The other heald is then

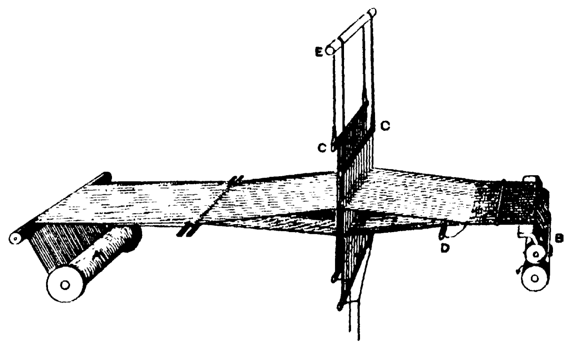


Fig. 5. -The Parts of a Simple Hand Loom

pulled down, and the shuttle passed back through the shed. These operations are repeated over and over again, until enough cloth is made. As the cloth is made it is wound on the beam B.

How to Weave Patterns.—For many hundreds of years cloths were woven of one colour only, before weavers dreamed that they could work a pattern in the body of the cloth. Cloths were woven of dyed yarns, all of one colour, or dyed in the cloth after being woven. In

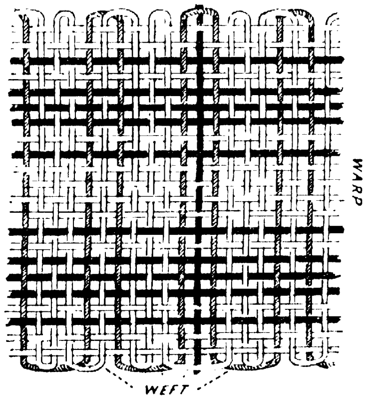


Fig. 6.—Diagram showing how a Simple Pattern is Woven. The different shading indicates different-colour threads

course of time some weaver thought that he could introduce two or more colours into a piece of cloth by using as many shuttles. Suppose he wanted to make a pattern of red and white stripes. He would first work in the weft so many threads of red, and then he would take another shuttle containing white yarn and work a white stripe. At first only the weft was treated in this way, but it soon became evident that the warp threads could be of different colours. In this way, by varying the colours of both warp and weft, squares and oblongs could be made in the designs. All this can easily be done on the plain loom.

The tartans of the Scottish highland clans are excellent examples of pattern cloths of the kind just referred to. They are very simply woven, but, nevertheless, very beautiful effects can be produced.

Another variation in the weave consists of dividing the warp into three or more groups of threads, each with its heald, instead of into two groups only, as in the simpler form of weaving above described. For instance, warp threads 1, 4, 7, 10, 13, &c., might be on one heald; 2, 5, 8, 11, 14, &c., on a second heald; 3, 6, 9, 12, 15, &c., on a third heald. By operating the healds suitably the first weft thread might pass over warp thread 1, under warp threads 2 and 3, over 4, under 5 and 6, and so on. The second weft thread might be passed under 1 and 2, over 3, under 4 and 5, over 6, and so on. In this way a *twill* can be woven.

HANDWORK WITH PEGS, ETC.

Materials.—Thin rounded pegs of wood (pins do, but are by some thought to be dangerous), a number of white peas, or, better still, small pieces of cork cut into cubes.

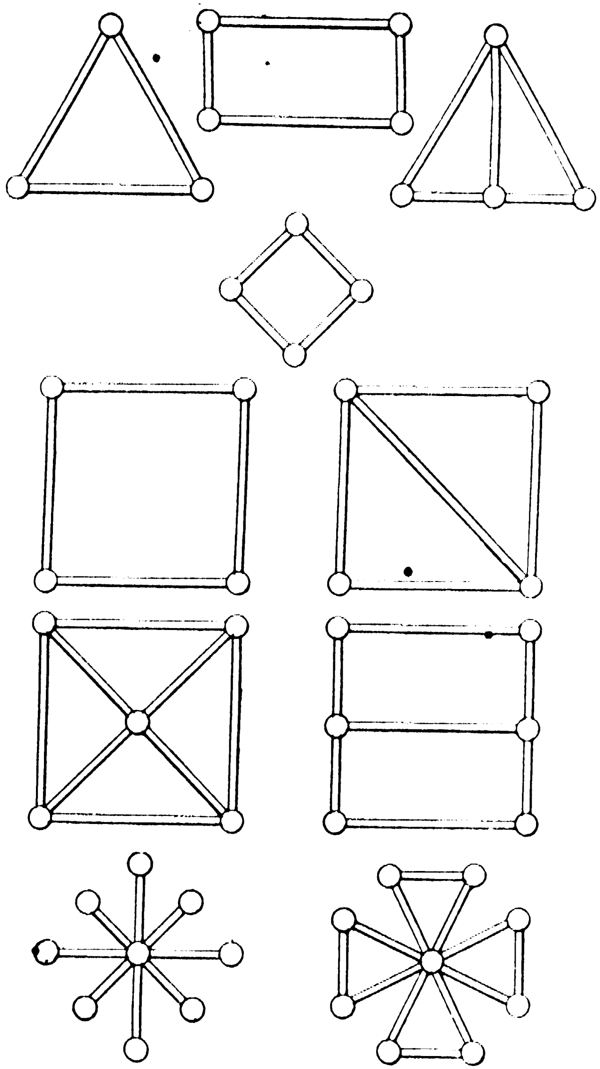


Fig. 7.—Superficial Forms made with Pegs

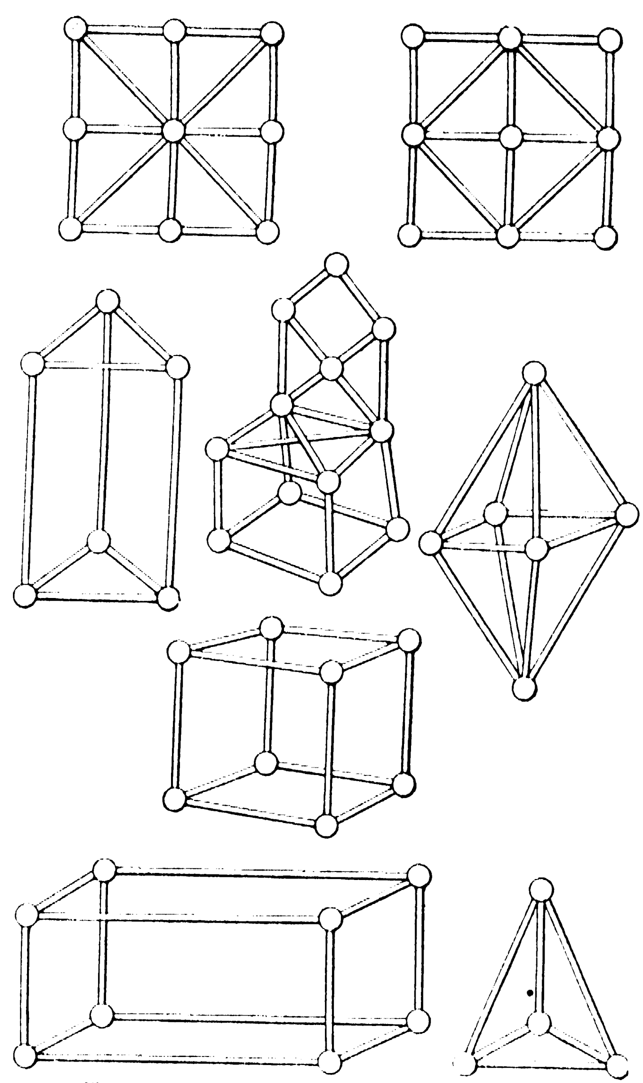


Fig. 8. Outlines of Solid and Other Forms made with Pegs

If peas are used they must be soaked in cold water for about twelve hours, and dried for one hour previous to being used. They are then just soft enough to receive the peg, and yet hard enough to hold it. The illustrations (figs. 7 and 8) present various suggestive forms.

STICK LAYING

Stick-laying exercises, with round sticks or with flat ones (known as *laths*), are most useful for developing ideas of number and form. The

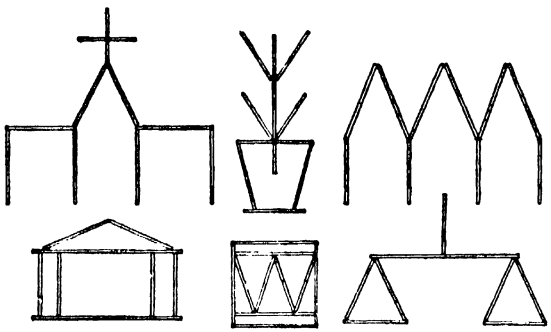


Fig. 9.—Familiar Objects formed with Sticks

following illustrations of some convenient forms will prove suggestive; they can be varied almost indefinitely. By the use of coloured sticks pleasing variety is obtained.

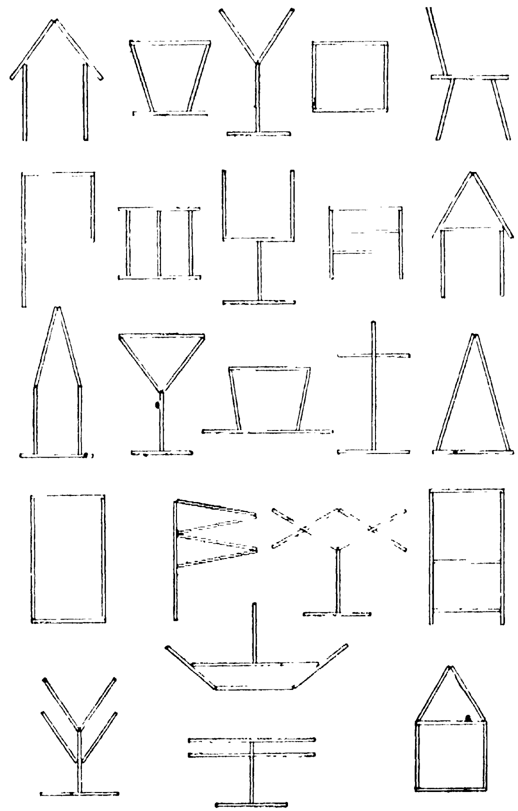


Fig. 10.—Familiar Objects formed with Sticks

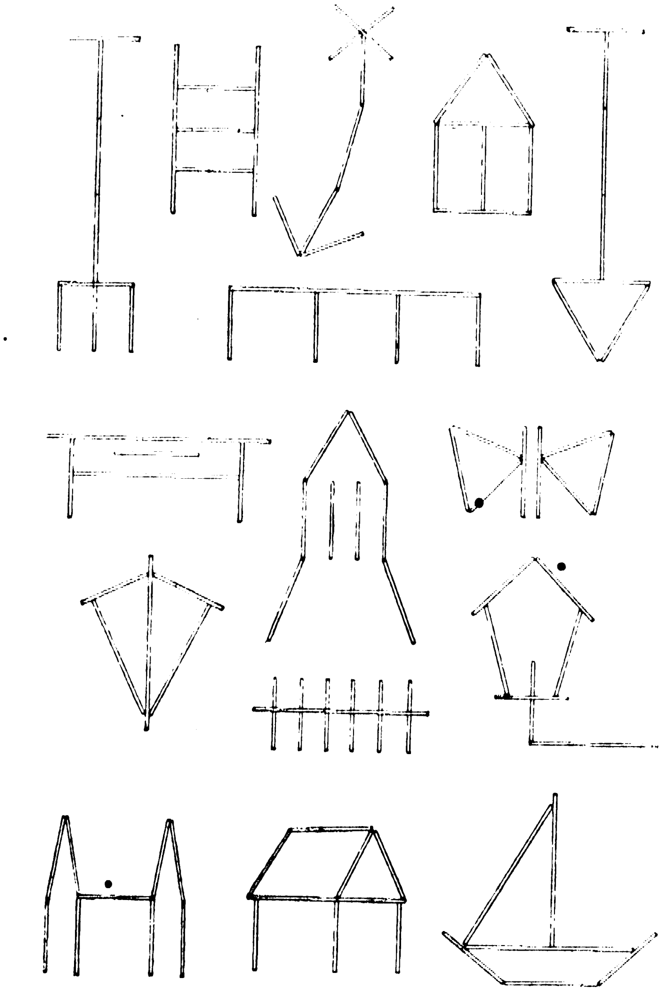


Fig. 11.—Familiar Objects formed with Sticks

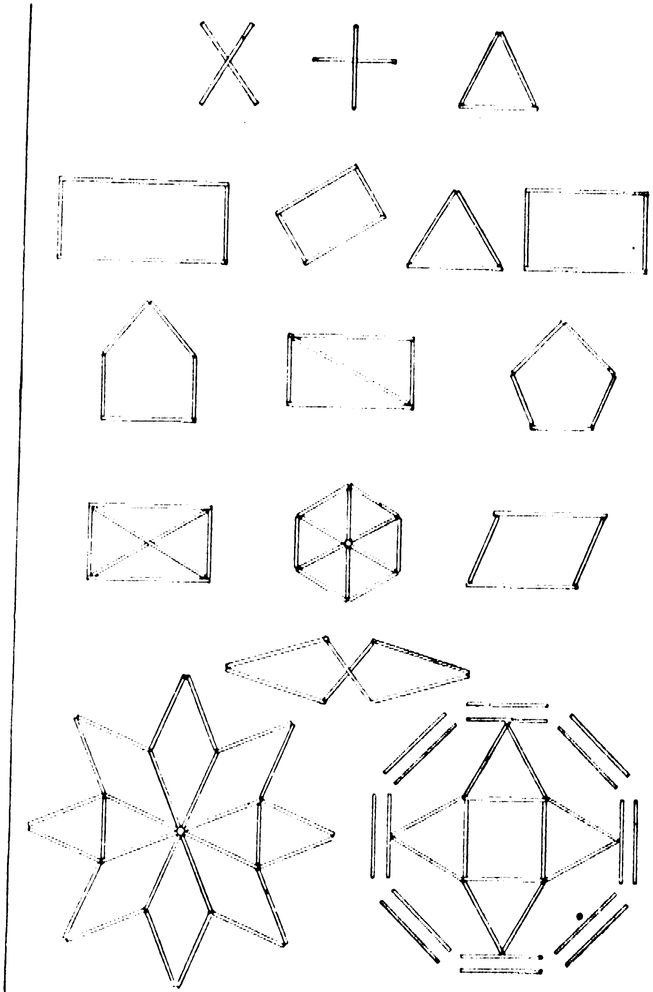


Fig. 12.—Regular Forms made with Sticks

UNRAVELLING

Materials.—A number of pieces of some woollen stuffs of various colours cut into pieces about two inches square; a number of pieces of thick paper or cardboard on which to place the ravellings; boxes for holding the pieces of stuff and the ravellings; a number of pieces of straw.

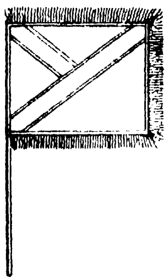


Fig. 13

The children to unravel. See that they place each thread on the card in an even direction. Threads unravelled on three sides of the pieces of stuff.

Flags. — The partially unravelled pieces may be made into flags. Thus: Cut the straws which have been provided, into lengths of 5 or 6 inches, make a split at one end, and into this insert the edge of the piece of material which has not been unravelled (fig. 13).

Dolls.—The ravelling may be tied up to represent dolls, the body made of white ravellings, the bonnet and dress of coloured (fig. 14).

Brush.—The ravelling fastened to one end of a thin piece of wood forms a neat handbrush (fig. 15).

Bird's Nest.—A pretty bird's nest, with a bead or two put in to represent eggs, can be made, as in cut (fig. 16).

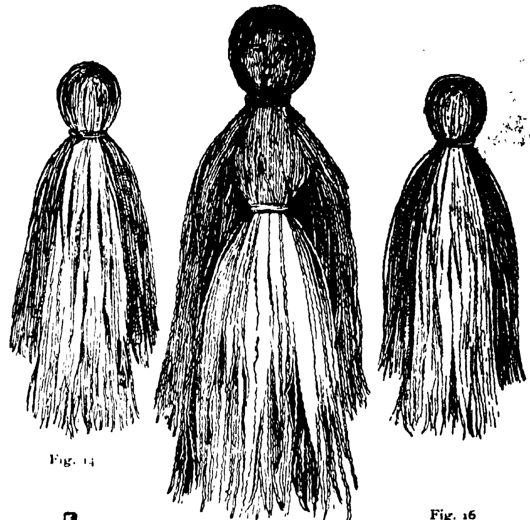


Fig. 14

Fig. 16

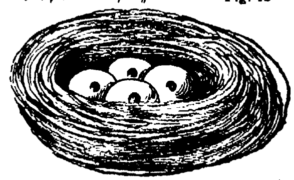
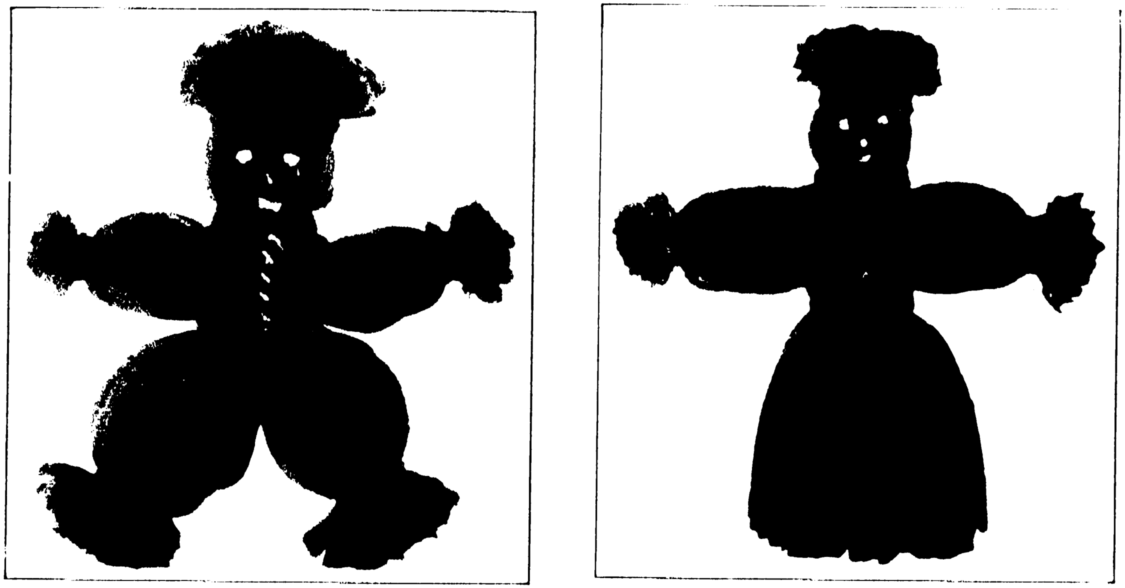


Fig. 17

Fig. 15

WORSTED DOLLS



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Strawberry.—A piece of the material for ravelling, with some of the ravellings inside, may be tied up for a strawberry (fig. 17).

Pin Cushion. — Two squares ravelled on all sides, sewn together, and stuffed with the ravellings, form a pin cushion (fig. 18).

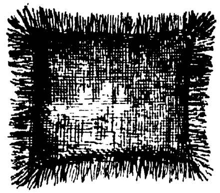


Fig. 18

WORSTED DOLLS

Worsted dolls are easily made, and may be dressed as boy dolls or girl dolls. Their construction is as follows.

Take some worsted, preferably of a bright colour, and wind it longways round a small book or a piece of cardboard, about 6 inches long, until a skein is formed of the desired thickness for the doll's body (see Plate). Slip the skein off, and tie it round tightly, about ½ inch from the top, to form the top of the head, and then again, more tightly still, about 1 inch farther down, for the neck. Next wind another and thinner skein round the book or card broadways, and slip it through the first skein, from side to side, to form the arms. Tie the body below the arms to make the waist. Divide the legs and tie the ankles. Tie the wrists; and, lastly, take a pair of scissors and cut all loops on head, neck, and feet, trimming them neatly and evenly. Then take some worsted of a contrasting colour, and mark in the features.

SIMPLE TOY MAKING[1]

KITCHEN FURNITURE

A Round Table.—Take a pickle cork, put four pins for its legs, and ray nine or ten more out from its top, as shown. Then twist wool from pin to pin to form top, and twist round each leg. This is done by beginning at the top, going down to pin head, then back to top, and on to the next leg. To get the rail, go back as far up the pin as the place where you desire the rail to be, and proceed from leg to leg (fig. 19).


Fig. 19

An Armchair.—Lay two corks for the chair-seat, putting four pins as legs, and six to form the back

[1] In this section, and in the section on handkerchief folding and paper folding and cutting, Miss Jennett Humphrey's delightful book, *Laugh and Learn*, has been largely drawn upon.

and arms. Cover the legs with wool to get the rails as above, and twist the wool along the pins of arms and back (fig. 20). Make a cushion of the tiniest piece of chintz or what not.

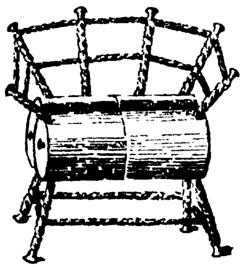


Fig. 20

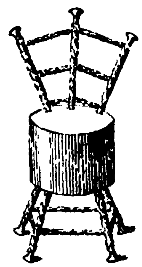


Fig. 21

A Small Chair.—Cut a cork in half; put four pins in for legs and three for the back. Cover them with wool to show rails, as above (fig. 21).

Knitting cotton or darning cotton will do for all this kitchen furniture.

A Three-legged Stool.—Form it of half a very small cork, the legs to be of three minnikin pins (fig. 22).

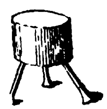


Fig. 22

A Clock.—Drive two corks together, with pins, as foundation; then drive two more, column-wise, on the top. Make little cardboard clock-face, and fasten on

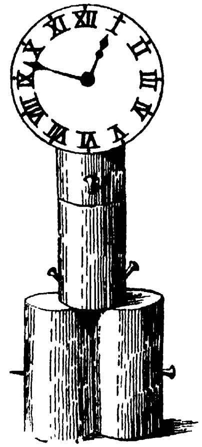


Fig. 23

with pin. Write hours on the face, and draw the hands (fig. 23).

Mantelpiece.—Drive two corks together for each side of it or "jamb", then cut a piece of cardboard, and pin it on to form the shelf (fig. 24).

Saucepans. — Half of a small cork, with a pin put in as a handle, will make a neat saucepan. Put such on the mantelpiece (fig. 25).

Cocoanut-shell Scales.—Pierce holes in two half-cocoanut shells, and suspend to a strip of wood with string. Let these be

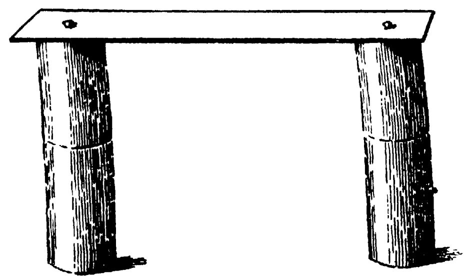


Fig. 24

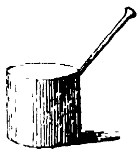


Fig 25

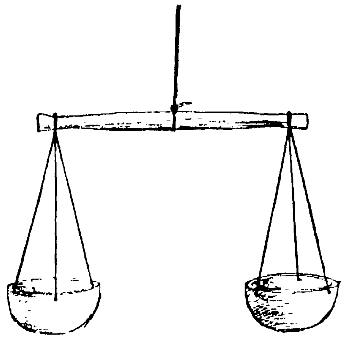


Fig 26

hanging scales, by suspending them from some convenient place (fig. 26).

DRAWING-ROOM FURNITURE

A Table.—Take the largest and flattest chestnut you can find. Put four pins for legs, and a ray of pins round the top. Twist tinsel from pin to pin for the top, and from pin to pin, cover the legs, and continue the tinsel all over. Filoselle will do, or any flossy silk. A pretty effect is gained by one thread of the tinsel at the top of filoselle; also by a gold bead at the head of each pin. The object in entirely covering the legs is to look like rich drapery (fig. 27).

Fig 27

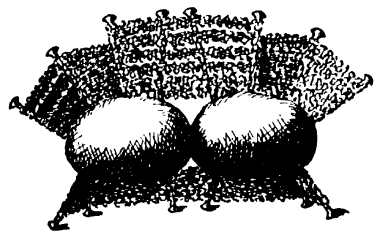


Fig. 28

A Sofa.—Drive two chestnuts together with pins, put other pins for legs and back, and cover continuously with tinsel or the selected material (fig. 28).

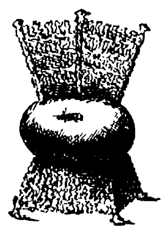


Fig. 29

A Small Chair.—Take one chestnut, and use the same method precisely as the foregoing (fig. 29).

A Cabinet.—Drive three chestnuts together by long and large-headed pins, as shown in cut, putting the flat side of the nuts uppermost. Then put in four pins as legs, and cover these continuously (fig. 30).

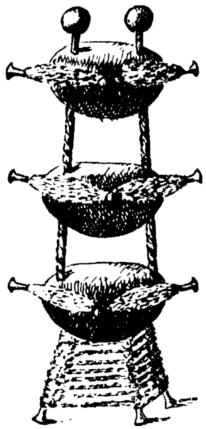


Fig. 30

Armchairs. — A small chair can be made into an armchair by continuing the back pins nearly to the front, and having these front pins smaller than those at the back. See fig. 20.

Footstools. — Put pin legs on the smallest of the chestnuts, and cover the legs. Put no back.

Cork Baskets.—I. Take a flat pickle cork; surround it with pins (as shown in fig. 31), with a hairpin as handle. Then twist wool round from pin to pin, beginning at the base and going upwards. At end of the last round twist the wool over the handle, attaching it to pin at each side to keep it firm.

II. Cut an ordinary cork in half the tall way, then surround the top with small pins. Cover the cork with wool, or before putting in the pins cover it with any bright piece of stuff. Then twist wool from pin to pin, as above (fig. 32).

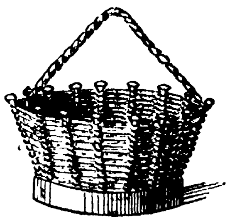


Fig. 31

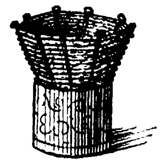


Fig. 32

BEDROOM FURNITURE

Proceed with chestnuts for the chairs in precisely the same manner, but substitute bright wool for the tinsel and filoselle. Either cover the pins continuously or adopt the rail manner, according to preference.

A Bed.—Take a cardboard box and put the body of it into the lid, at once forming the bedstead. Make four legs to it, of two chestnuts each, choosing small chestnuts for the under ones. It will not be enough

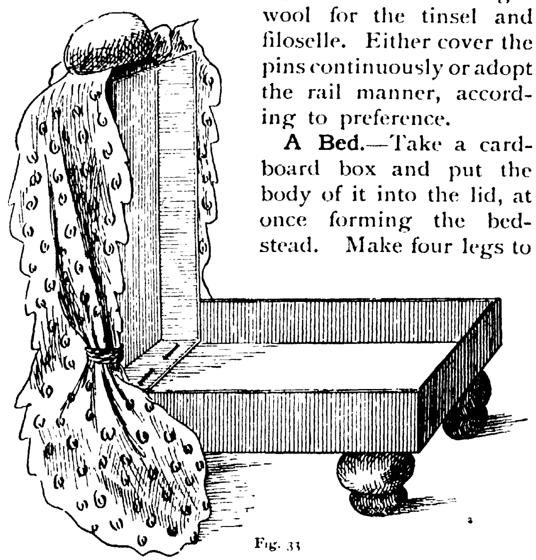


Fig. 33

to run a pin into these to secure them; you must run a thread or thin twine as well, and such running will also secure the head firmly. Then take a narrow length of chintz or muslin, sew it down in the centre of the head, ornamenting such sewing by a chestnut; let the ends fall in equal lengths at both sides, sewing them in at the bed level in curtain fashion. Make little mattress and bedclothes to fancy (fig. 33).

A Towel-horse.—Drive a hairpin through two chestnuts, keeping one at each end. Drive two

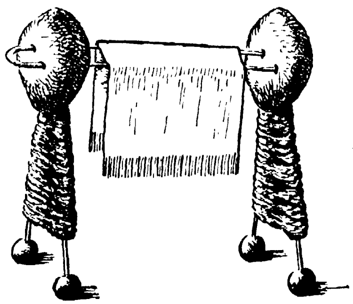


Fig. 34

pins into each chestnut for legs, and twist wool round these as before. Large black-headed pins, as shown in fig. 34, are best. Put a tiny towel on.

GARDEN AND OUTDOOR FURNITURE

A Table.—Take a rectangular piece of card and put under it four corks, with pin run through each. If your pins are longer than your corks,

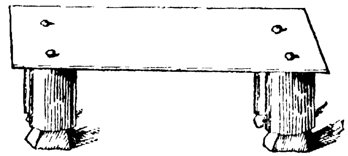


Fig. 35

divide a cork into pieces, and put a piece under each leg, as shown in fig. 35. It adds also to the effect.

A Garden Seat.—Bend a piece of cardboard and put four corks under for legs. Thrust pin through each (fig. 36).

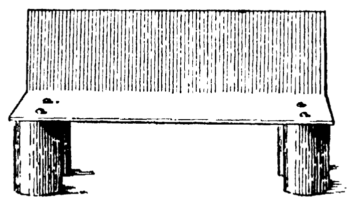


Fig. 36

A Tree Seat.—Tie seven corks firmly together, as in fig. 37. In the centre one cut a hole, into which put a stick or an old penholder. Round

off the corners of a piece of card; cut hole in the centre; put it flat on to the corks over the penholder, thrusting in a couple of pins to secure it. Take another piece of card, cut a hole in the centre, and make any odd zigzag cuts all

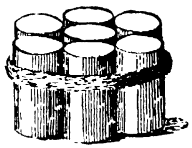


Fig. 37

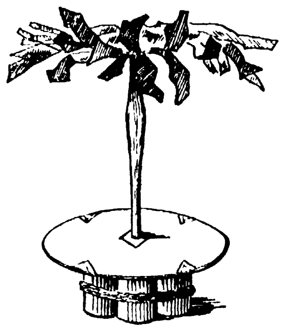


Fig. 38

round it. Then put it on top of penholder, bending down the zigzag edges branch fashion (fig. 38).

A Bridge.—Cut a piece of cardboard about

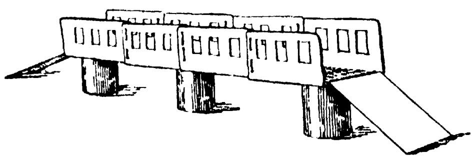


Fig. 39

9″ × 3″. Cut the edges as shown (fig. 39). Then bend up the sides as shown (same illustration), put three corks underneath, and thrust a pin through each. Four pieces of card (the size of ordinary playing cards) sewn together will do, if a long piece of cardboard is not available.

Approaches to the Bridge.—Cut two pieces of card, each the size of a playing card halved the long way, and slant them from the bridge level to the table at each end.

A Boat.—Bend a card as in fig. 40. Put a few stitches at each end, leaving a piece of cotton

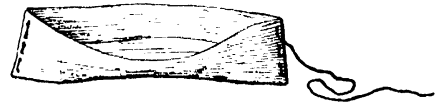


Fig. 40

at one end by which to drag it along, under the bridge.

Noah's ark animals can be carried in this boat; and such animals can be used with all this furniture, and will make a very attractive picture.

Cart Wheels.—Drive each end of a stick or an old penholder right through a chestnut. Then

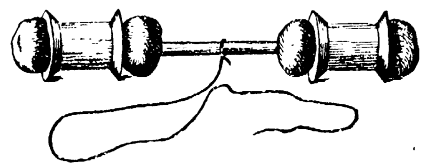


Fig. 41

push on a cotton reel after each chestnut. At each end fix another chestnut, by which means

the reels will be kept in place. Tie a string to centre, and it will roll excellently. Half-chestnuts will do for the extreme ends (fig. 41).

Cart.—Prepare two of the above cart wheels, but without the inner chestnuts. In place of these put the bottom of any box—cardboard or wood—and tie it round the axle-tree close to

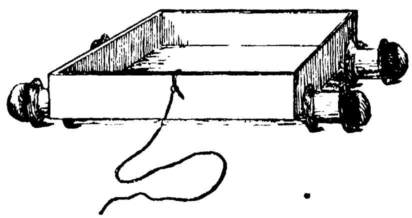


Fig. 42

the reels. Tie a piece of string to draw it by (fig. 42).

A Street Lamp.—A penholder through an empty reel, and a chestnut stuck at the top, makes a lamp, or a tree, as required. Any slips of wood will do instead of penholders.

The Wrestlers.—This may entail more cutting of corks than is feasible for very young children, but the operations are really very simple, and the toy is so interesting that it is worth constructing. It is a great delight to the children.

Take two corks to form the wrestlers' bodies. Cut another cork in half, and shape each half a little to form the wrestler's head. Then, by means of a pin, fix a head on to each body.

Fig. 43

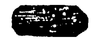


Fig. 44

Cut pieces of cardboard, thus: two as in fig. 43 for arms, four as in fig. 44 for thighs, four as in fig. 45 for legs.

Fig. 45

Attach the legs to the thigh by cotton, knotted on each side, not stitched backwards and forwards, because that method would take away the play of the limbs. Attach the top of

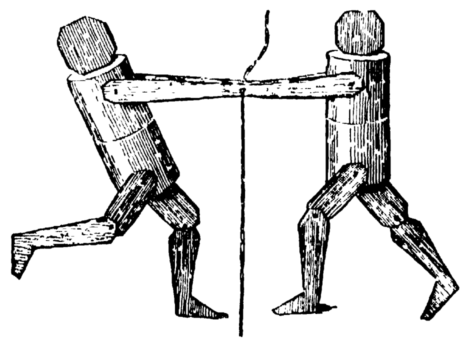


Fig. 46

the thighs to the body in the same method, and the arms to the shoulders. Lastly, run black

cotton through the hands, knotting them together; from one side leave about half a yard of the cotton, with a loop at the end, which you must pin down on the tablecloth. From the other side leave about a yard of the cotton, which you hold in your hand, rather elevated; and as you gently move this cotton the figures wrestle (fig. 46).

STRING WORK

Chain Work.—Have three pieces of twine, one piece thicker than the other two, and long enough to tie it round the child's waist. Tie the three pieces together at the top. By the loop formed in the tie pin this top securely down to a heavy cushion, or any suitable place, and tie the centre piece round the child's waist, making it entirely tight. The child is then to twist one of the fine twines round the centre one, close up to the knot, and draw it tight; and twist the other one, drawing it tight; and proceed in the same way alternately, all along. The centre string becomes quite hidden, and a very strong braid or chain is produced. This worked in stout silk is quite proper and effective. A bead can be slipped up here and there for embellishment (fig. 47).

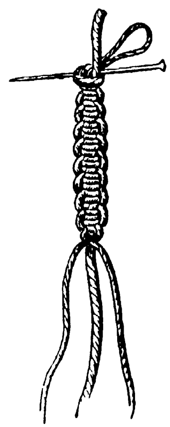
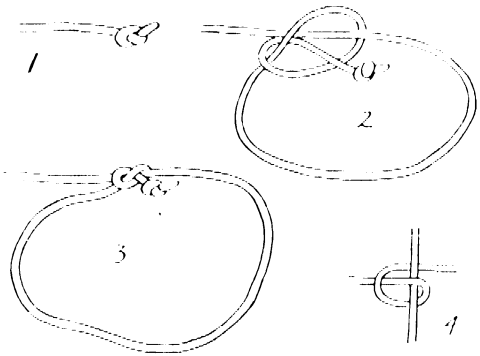


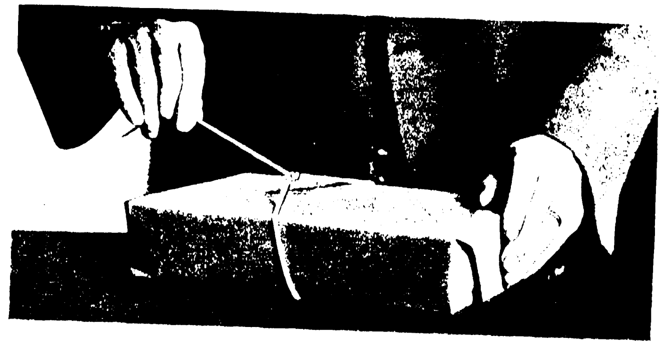
Fig. 47

To Make a Slip-knot (also called a Running Knot).—Tie a knot on the end of the string in the usual way. Take the knot in the right hand and the length of string in the left. Form a loop by bringing the right hand up to the left, catching the string at the crossing between the thumb and first finger of the left hand two inches from the knot. Drop the knot behind and pull it through the loop, bringing it close against the thumb of the left hand. Push the knot through the small loop thus formed, and tighten the string. It is very simple, and the method is easily seen from the accompanying diagrams. (See Plate.) It is most useful for even the smallest children to learn how to make a running knot, and they are always most interested in practising it.

To Tie a Parcel.—Make a large loop as above and pull it over the narrow end of the parcel, or better still, make the loop on the parcel itself, as shown in fig. 5 in Plate. Tighten it, then carry the string round the end of the parcel, intertwining it at the back of the parcel with the cross string as shown in illustration (fig. 4). Continue the string round the parcel, carry it over the cross string and under the end string, then

TYING A PARCEL





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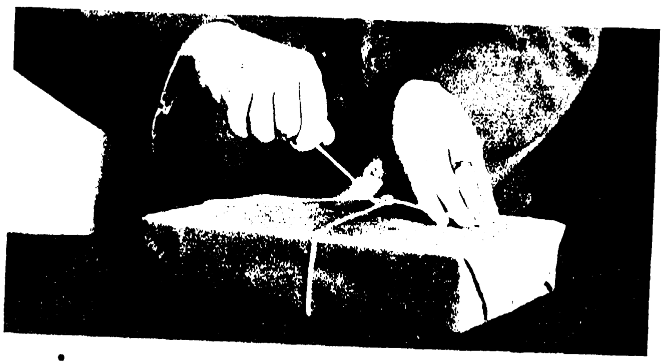

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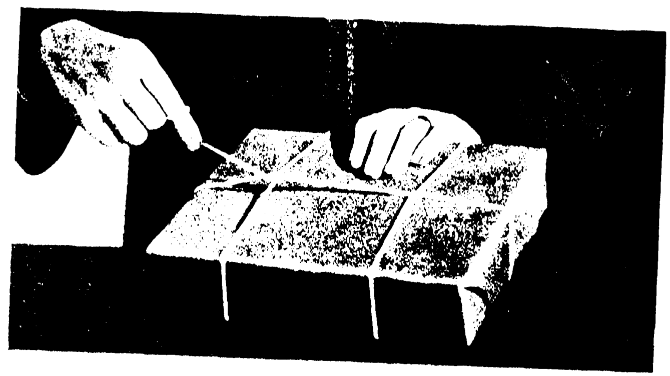

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back over the cross string and fasten (fig. 6). Fig. 7 in the Plate shows two cross strings. The second one is made by carrying the string again round the parcel and forming a loop by passing the end over and under it, bringing the end out at the side nearest the first cross string.

MAIZE-SEED BEADS

These answer for beads. Soak them in cold water for a day or two, when you can pierce them with a stout pin. At this point they are ready for the child, who can then string them (fig. 48), or sew them on to any dark-coloured patch piece. In this last case, teach the child to make a stitch between each seed to keep it in place.

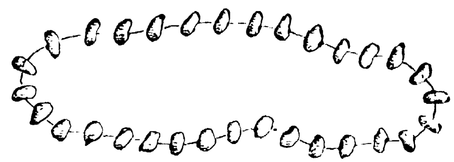


Fig. 48

When the seeds are done with as playthings, put them on the window ledge outside the window. The birds will come for them. The more bruised they are the better for the birds.

HANDKERCHIEF FOLDING

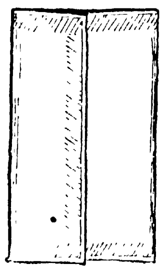


Fig. 49

A Handkerchief Cap (The Crusader).—Fold a handkerchief right side to middle, and left side to middle, rather to overlap (fig. 49). Bend down the two near corners (fig. 50). Roll up from there, tightly, till about halfway; then completely turn the flaps over the roll. The cap will sit on the head as in fig. 51, the straight part falling at the back.

A Handkerchief Rabbit.—

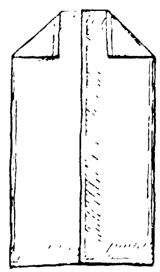


Fig. 50

Fig. 51

Fold a handkerchief in half, crossways; and turn the two long points in towards one another along the top (or base of the triangle), but not quite to meet. Roll up this top, folded points

Fig 52

and all, till only the peak is left unrolled. Turn it then, back upwards. Double in the two thick ends till they overlap. Fold the peak over these doubled ends into centre, and work the little bundle round and round until the first two long points can be drawn out (fig. 52). Twist and tie

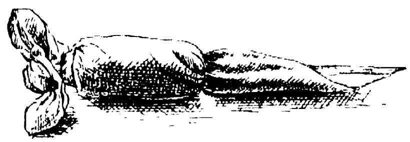


Fig. 53

one of these points to form ears; let the other hang as a tail. That will be the rabbit (fig. 53). Jerk it forward on your sleeve, or on to the child, with adroit (and concealed) touch on the body; catch it by the tail; fondle it; &c.

A Judge's Wig.—Fold a handkerchief crossways, and cross the doubled corners rather slantways (fig. 54). Draw the upper of the two points up to the cross, and roll up; turn all the roll in, and let the peak hang down. It forms the wig shown in fig. 55.

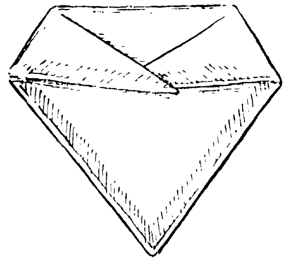


Fig 54

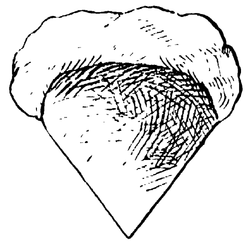


Fig. 55

A Handkerchief Man.—Spread a handkerchief or table-napkin on the table, and roll one side of it quite tightly up to the middle, and the other side quite

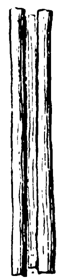


Fig. 56

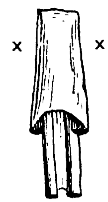


Fig. 57

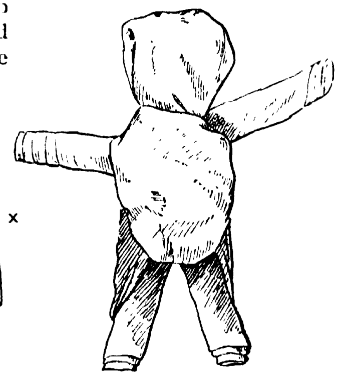


Fig. 58

tightly to meet it (fig. 56). Turn one end nearly down to the other end (fig. 57). Take the uncovered end, turn it up, over the part just doubled towards it, and tie it round the part marked with crosses on the illustration. By tying it tightly, and adroitly pulling straight the ends of the tie, they simulate arms, the top appears a head, and the remainder the legs (fig. 58).

PAPER FOLDING AND CUTTING

(See also page 41 *et seq.* of this volume)

PAPER FLOWERS

Roses. — Cut strips of white and pink tissue paper, about 6 inches wide, the whole length of the sheet. Double the strip (long way), then pleat and crumple and pucker up the cut sides, round and round, till the rose shape is there. Secure it into shape by twisting cotton round, and mount it on wire. For a bud, take a 6-inch square of the paper, and crumple it to form. Mount that on the wire also (fig. 59).

Fig. 59

Convolvuluses. —Cut pieces of white, pink, and peach tissue paper about 6 inches by 4 inches. Double each piece (long way), and tack it into a round. Have ready pieces of yellow tissue paper cut into shreds at one end; roll these up at the uncut end, and pass them through the rounded piece, the shred ends

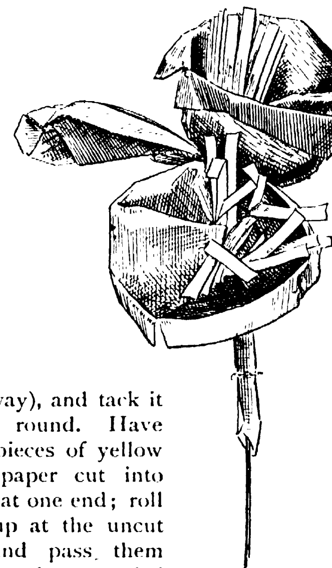


Fig. 60

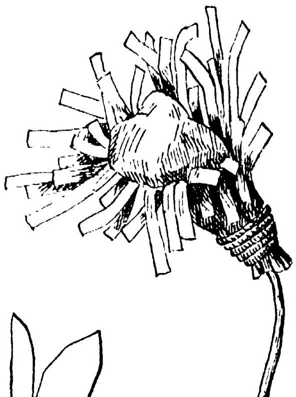


Fig. 61

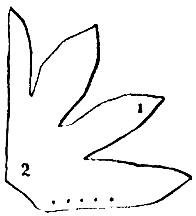


Fig. 62

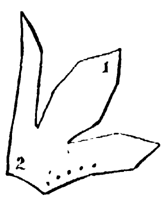


Fig. 63

at the double edge. Crumple the rounded piece up into bell shape, the shreds for stamens; turn the double edge back a little, and mount on wire. Form buds as for roses (fig. 60).

Make these larger, and of crimson, brown, or purple paper, and you may venture to call them hollyhocks.

Marguerites. — At the top of a piece of wire, twist round a drumstick head of yellow tissue paper. Shred one side of a strip of white tissue paper, and twist the unshredded side round the yellow (fig. 61).

Do this on a larger scale with orange drumstick head and yellow shreds, or any colour shreds you please, and they can be called Chrysanthemums.

Lilies. — Shred one side of pieces of amber tissue paper, and twist them round wire for stamens. Cut doubled pieces of thick white paper as in fig. 62, the petals not dotted being the doubled side. Tack together those petals marked with dots; this

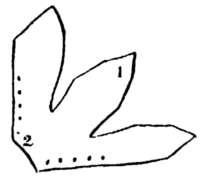


Fig. 64

Fig. 65

will form the lily, which is then put round the stamens, and secured in place by cotton. That the lilies may not be all one size, cut some pieces of the paper (after doubling it) as in fig. 63.

Tack together at the dots, and proceed as before. For buds cut single paper as in fig. 64, and tack at dots, proceeding as with the rest. The size should be about 4 inches from 1 to 2 in all cases, and each petal be about 1 inch across. Fold back the petals very, very slightly at the tips, for effect. Mount the lilies in sprays (fig. 65). Orange-coloured paper instead of white over the amber stamens is very effective.

Any of these flowers put amongst real foliage in vases have a charming effect; and children, as in most of the diversions suggested, can help in many of the processes, though some of them would be too difficult.

THE MAGIC FOLDS

To carry this series of folds to completion involves some patience; but the teacher will know how far the children can follow. It is not necessary to go through the whole series, though the whole is interesting. One thing is of importance in this as in all folding exercises, namely, **accuracy of folding**, and indeed the discipline in accuracy and neatness is the great benefit to be derived from the exercise.

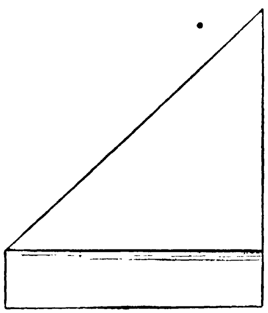


Fig. 66

Fold the paper (a half-sheet of notepaper) as at fig. 66; fold back the over piece, and cut off with paper-knife neatly, leaving it a double triangle. Then triangle it over the other way, and fold down neatly. Open it flat (fig. 67), and fold in four angles to centre, as at fig. 68. Turn it over, and fold in four angles to centre again, reducing the size to fig. 69. Turn once more, and fold in four angles to centre, reducing the size to fig. 70.

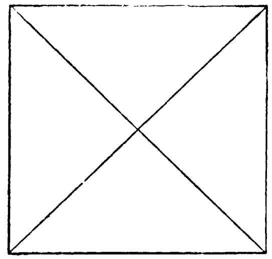


Fig. 67

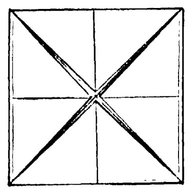


Fig. 68

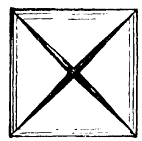


Fig. 69

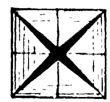


Fig. 70

You can, during this, have amused the child by telling it that 67 and 68 are handkerchief cases, and 69 and 70 footstools (which they

become if you turn them over a moment and stand them on their firm-folded peaks).

A Waistcoat.—Turn fig. 70 over, and open out the two angles marked C, CC on fig. 71. Fold down neatly.

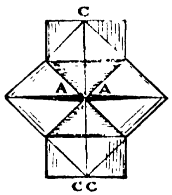


Fig. 71

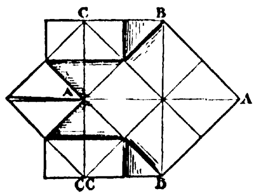


Fig. 72

A Jacket.—Take one of the peaks marked A on fig. 71, and open it out as in fig. 72. Put the two angles marked B to centre of back, when the A can be turned down, for one sleeve of

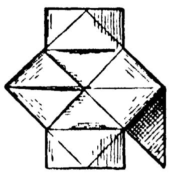


Fig. 73

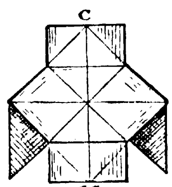


Fig. 74

jacket, as in fig. 73. Then take the other A and proceed in the same manner, when you will get both sleeves to the jacket, as in fig. 74. Note, also, that you can equally turn these sleeves up, asking the child which it would like; and you can have one up and one down, as if to get the jacket off. Make plenty of play out of the various positions, crying "Help!" when the arms are up, "Stand at ease!" when they are down, &c.

A Table.—Pull out the C and CC of fig. 74, and you will revert to fig. 68, which lay flat, the inner angles downwards. Then nip in the peaks as in fig. 75, and the table will stand.

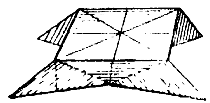


Fig. 75

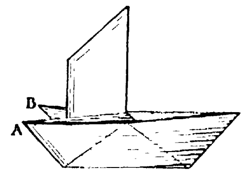


Fig. 76

A Boat with Saloon Cabin (fig. 76).—Turn the table on to its top. Pinch close together, upwards, to shut it up, the right-hand peak, and then the left-hand ditto (or those at the top and bottom do equally well), which will begin to shut the square up. Then draw the two pinched peaks together tightly to your right hand (marked A, B in fig. 76), and they become the stern of the boat, and the saloon cabin will be properly on deck. Bend out the top of it a little, canopy-wise, for better effect.

At this point you can give the child much amusement. Tell it to hold the saloon cabin, and shut its eyes, not peep a bit. Then rapidly fold the opposite way your pinched peaks (alias

the stern), when what had been the boat's bow will become the saloon cabin, and, on telling the child to open its eyes, it will find that it is holding what will seem to be the boat's bow, whilst the saloon cabin is topsy-turvy, and all the passengers drowned. Repeat this again and again, for, by the same manœuvre, any peak the child holds can be converted into what it does not expect it to be.

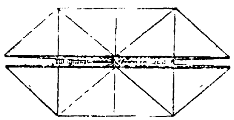


Fig 77

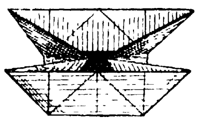


Fig. 78

A Purse.—Lay fig. 76 flat, on its flat square, and fold the upper parts down, as in fig. 77. Open up the top, as in fig. 78. Pick out inner corner of this opened top,

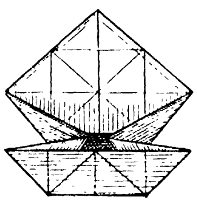


Fig. 79

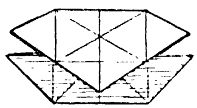


Fig. 80

as in fig. 79. Then spread it over the lower part, completely hiding it, as in fig. 80 (which shows the spreading in the act of being done, as a better guide). Fold backwards each of the three corners of the flap thus formed, then turn it over, as at fig. 81. Turn up the diamond face

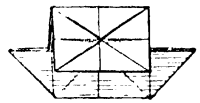


Fig. 81

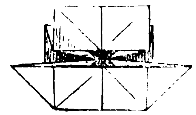


Fig 82

again and fold the square in half, as at fig. 82. Now do 78 to 82 to the lower half of fig. 77, bringing the shape out, as at fig. 83. Now

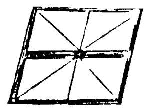


Fig. 83

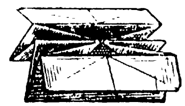


Fig 84

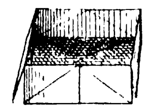


Fig 85

double that back, and you will find the purse with two pockets (fig. 84).

A Box (fig. 85).—Pull the purse out to a square, resting it on the bottom.

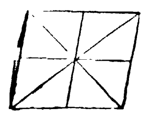


Fig. 86

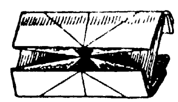


Fig. 87

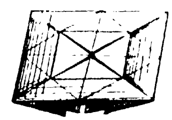


Fig 88

A Tray (fig. 88).—Put back box and purse, as at fig. 83. Turn it over, bottom uppermost, as at fig. 86. Fold inwards the sides with flaps, as

at fig. 87. Turn over and neatly pull out the sides, which will then face you. That is the tray (fig. 88).

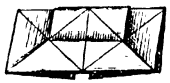


Fig 89

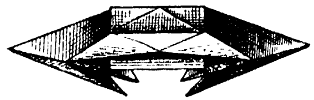


Fig 90

The Chinese Junk.—Fold the tray backwards, as in fig. 89. Pull out the opposite corners, as in fig. 90. Lastly, turn over and lift out the end pieces that will be found folded in, and the Chinese junk is obtained (fig. 91). A little stone or a button as ballast will enable it to sail nicely. Send it on various voyages for a cargo of tea, and the applause will be delightful (fig. 91).

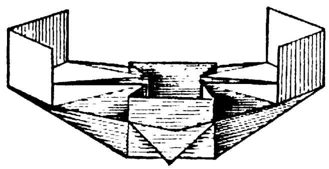


Fig. 91

MISCELLANEOUS FOLDING AND CUTTING

Brown-paper Baskets.—Take a piece of brown paper 20 inches by 12 inches. Cut two strips from it the whole length, $1\frac{1}{2}$ inches wide, and cut the remainder into two equal parts the square way. Double one of these squares in half, like a sheet of notepaper, and from the doubled side

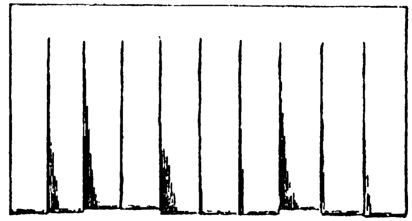


Fig. 92

up to within an inch of the edge cut about ten slits (fig. 92). Cut strips from the remaining

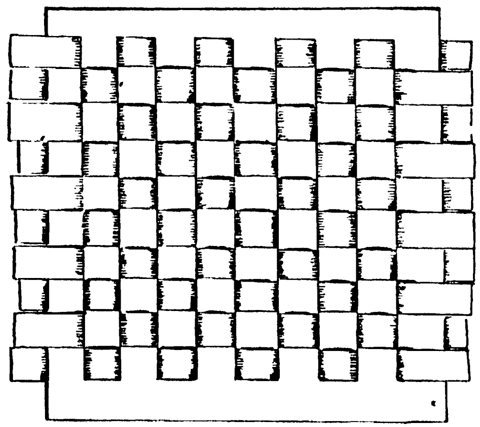


Fig. 93

half, and let a child weave them, warpway, in and out of the slits. That will make the square

as in fig. 93. Turn in all the ends; double the woven square up as it was before weaving, and sew the ends to keep it so. To form the handles, fold the whole-length strips into a quarter their width. This strengthens them, and allows them to go in and out of the existing warp and woof easily. Let them be thus woven in and out, and sew the ends of each strip together when done (fig. 94).

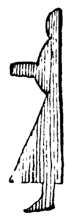


Fig. 95

These proportions are given because they really make a useful basket; but any others will do, and any kind of paper.

Note that this method is essentially that of the kindergarten coloured-paper mats, and of the

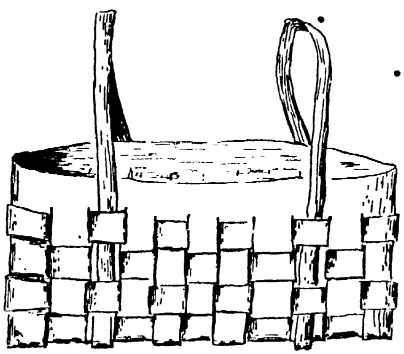


Fig. 94

real large brown-paper blanket, the meshes of which are about the size given.

Paper Dolls.—Take a strip of paper 12 inches by 2 inches (or any other dimensions). Double

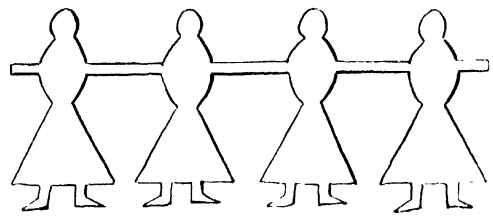


Fig. 96

it; and again double it; and again; and again. Cut as in fig. 95, being careful to leave the ends of the arms uncut. Then open, and it will be as in fig. 96.

A Paper Cross made by One Cut.—Bend over a piece

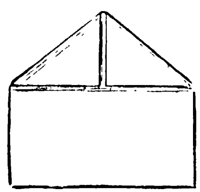


Fig. 97

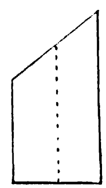


Fig. 98

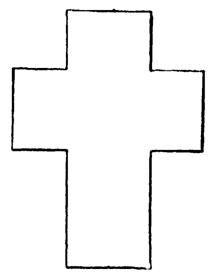


Fig. 99

of paper about a third of its length. Bend down the corners of the doubled head (fig. 97). Double that once, the corners in (fig. 98). Then cut

along the dotted line. When open it will be as in fig. 99. According to how far over is the first bend will the stem of the cross be short or long.

A Paper Cap.—Bend a square of paper in half. Bend down the corners of doubled head as in fig. 100. Fold up the loose piece marked F, one side over the corners, the other side up at the back. It is then as shown in fig. 101.

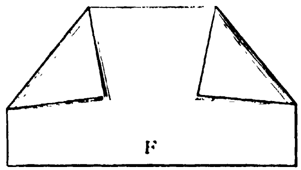


Fig. 100

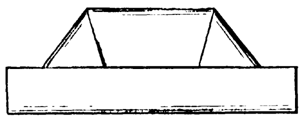


Fig. 101

Paper Chains.—Cut strips of coloured paper, say 4 inches by ½ inch. Make one piece into a ring, either by paste, needle and cotton, or a small piece of postage-stamp edging. Put a second piece through this,

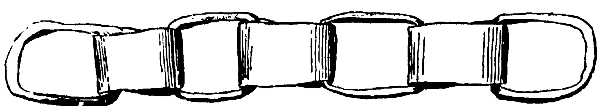


Fig. 102

making it a ring in the same manner; and from that add another, and to the other another, *ad lib.* (fig. 102).

Paper Box.—Have a square of paper and crease it as in fig. 103. Fold each angle into

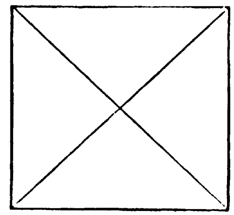


Fig. 103

the centre. Unfold. It will be as in fig 104. Crease A over to H, unfold; crease B to G, unfold;

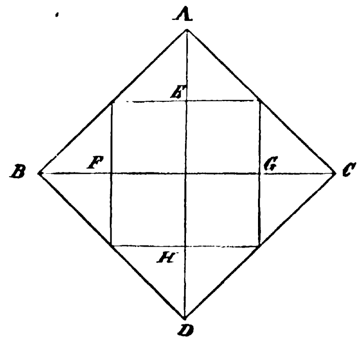


Fig. 104

crease C to F, unfold; crease D to E, and unfold. The paper is now as in fig. 105. Cut out the

eight pieces marked B, when the form will be as

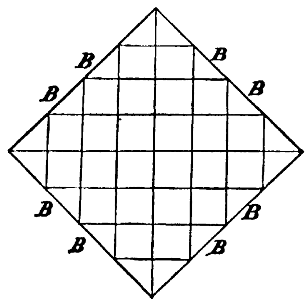


Fig. 105

in fig. 106. Cut down the dotted lines, the effect of which will be that the squares, of which they

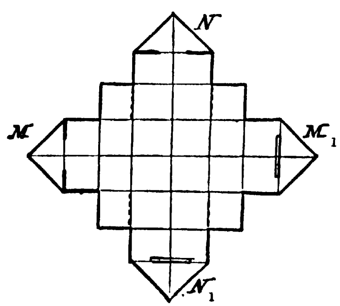


Fig. 106

are one side, will form doors, and the two peaks, MM_1, can be put perpendicular. Now snip the peaks M N where the thickened lines denote, fold back the snipped pieces as in fig. 107, which is merely for the purpose of allowing them to

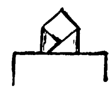


Fig. 107

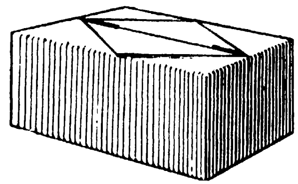


Fig. 108

pass through the buttonholes which are to be cut in the opposite peaks M_1N_1 as denoted. Button the M side first, and open the slits. Then button the N side, opening those slits, and it is completed (fig. 108).

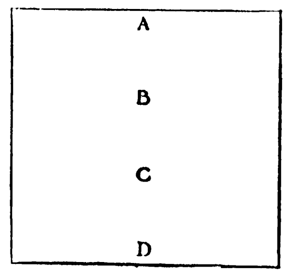


Fig 109

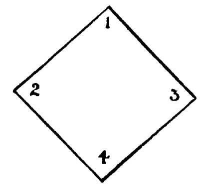


Fig. 110

A Paper Purse.—Fold a square of paper into three, A down to C, then D over the previous fold to B (fig. 109). Next, in precisely the same way, fold the folded piece into three, when it will have

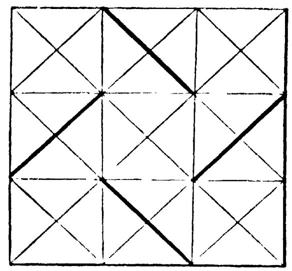


Fig. 111

become a square one-ninth of the original size. Then fold 1 over to 4; unfold; and fold 2 over

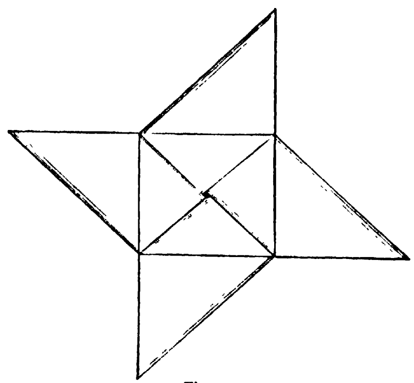


Fig. 112

to 3 as in fig. 110. Open the whole. It will appear as in fig. 111. Take the creases marked with the thicker line (which, if the folding has been done properly, should crease upwards and

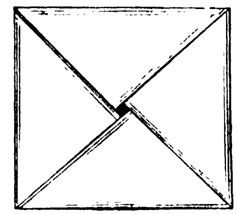


Fig. 113

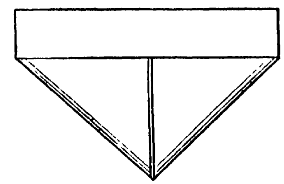


Fig. 114

not sink inwards), and so pinch them in that the whole folds up into fig. 112. Lastly, fold over

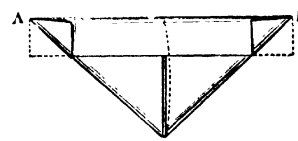


Fig. 115

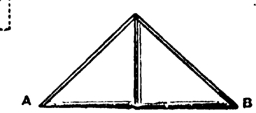


Fig. 116

the star pieces, one after the other, till the last, the point of which is slipped under the first, and the purse is then as in fig. 113.

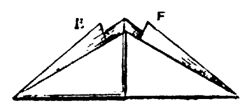


Fig. 117

Paper Boat.—Fold a doubled sheet of paper as in fig. 114; then fold the straight part over, one on each side. It will be as in fig. 115. Square it by opening at the dotted line, and letting A

touch B. Now turn A back, and turn B back, when the form will again be as in fig. 116, reduced in size. Square that, by the AB process; triangle it once more; and again square, and

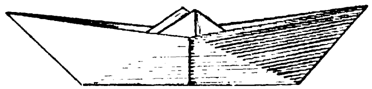


Fig. 118

again triangle. At the last triangling, take hold of the peaks EF (fig. 117), pulling them out, and the boat will appear (fig. 118).

These boats will float on water a long while, and if made in various sizes are very effective.

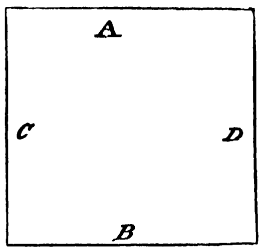


Fig. 119

At several stages of their manufacture they are Cocked Hats.

Paper Salt Cellar.—Crease a square of paper in half, A over to B. Unfold and crease over from C to D (fig. 119). Turn it over, and crease

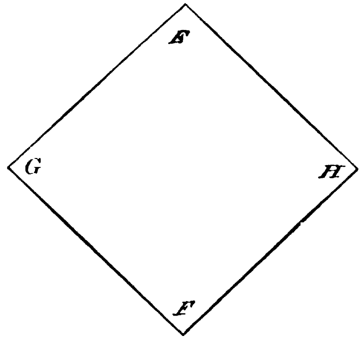


Fig. 120

it in half, E over to F; unfold and crease G over to H (fig. 120). Square it by creasing E F G H

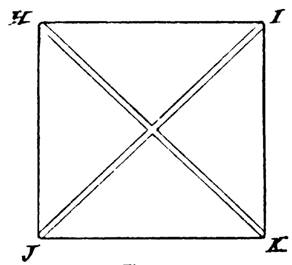


Fig. 121

into centre. Turn it over, and once more square it by creasing A B C D into centre. Turn it once more, when it will show as in fig. 121.

HIJK are now to become the feet of the salt cellar; and this is effected by squeezing them

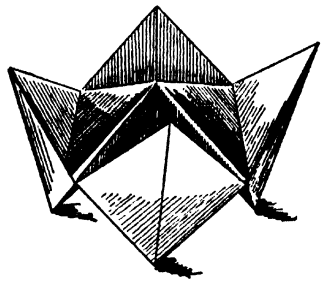


Fig. 122

downwards, which will raise their opposite angles, and raise the centre, when EFGH will open out, and the salt cellar be formed (fig. 122).

Paper Flycatchers.—Fold a square of tissue paper many times, and round off the corners. Snip up the edge as fringe, and cut as in fig. 123; the finer the better. Open it out, and hang it up by a cotton (fig. 124).

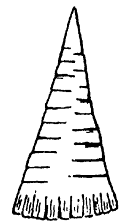


Fig. 123

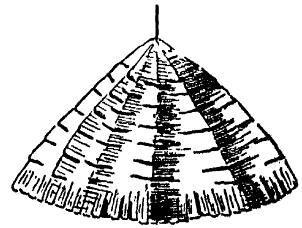


Fig. 124

An Aeroplane.—Take a piece of fairly stiff cartridge paper about 11 inches long by 9 inches broad. Fold down the middle, longways. Cut out as in fig. 125. Fold down flaps at either end (fig. 126). To hold the edges together, fix, as in fig. 127, with little pieces of wood (pieces of a wooden match will do) split at end to make tiny clothes pins. At the broad end fix also a long piece. To secure good balance put a match or a similar piece of light wood in the groove at broad end. Throw with small end forward.

AN AEROPLANE

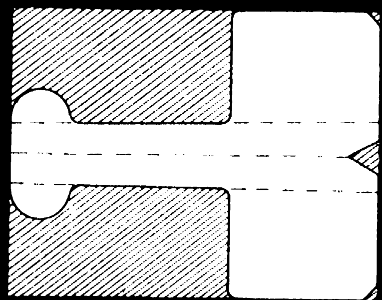


FIG. 125

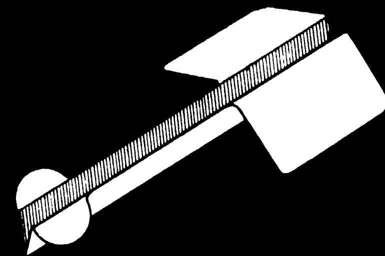


FIG. 126

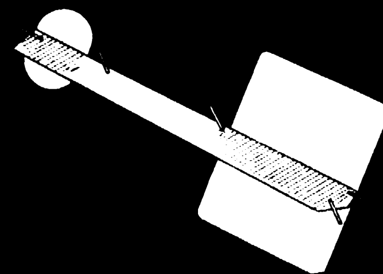
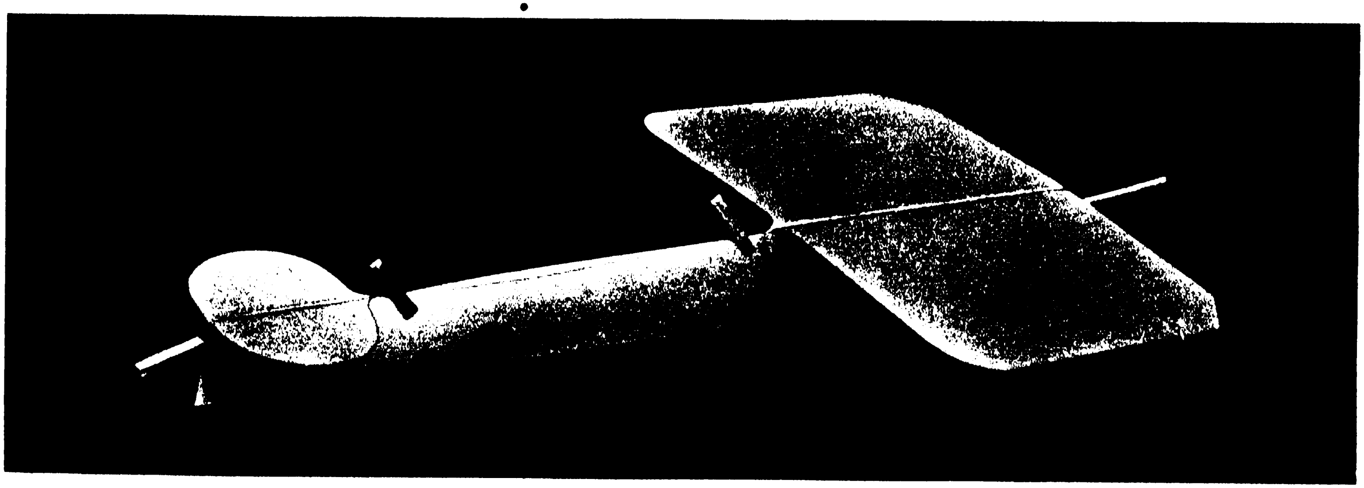


FIG. 127



Raffia Work

MISS M. P. GOTT

RAFFIA WORK

MATERIALS

During the past few years there has been a change in the kinds of handwork done by children in Infants' and Junior Schools. Transition stages have been passed through, with the result that difficulties are now felt when a choice of handwork is to be made. The forms of handwork known at an earlier time as the "varied occupations" of the kindergarten now receive more attention with regard to the utility of the completed models than they formerly did. For this alone the departure from earlier practices is commendable, and should therefore be welcomed.

It is not generally recognized, how great the value of variety of materials is, with respect to the aim for which handwork is included in the school curriculum. Teachers should endeavour to make a selection of materials and exercises of such a kind, that individual thought and expression on the part of their pupils would be brought out, and their inventive ability stimulated.

One of the materials more recently introduced into use in schools is raffia or raphia, the name given to a group of palms, the leaves, bark, and pith of which are employed for various purposes. The long leaf of a Madagascar palm supplies the raffia which is sold in this country. It has been pointed out that the huge fronds of this species were brought from Madagascar as the feathers of the fabled "Roc". A similar fibrous material is known as bass or bast. The name is specially applied by botanists to the inner fibrous bark of the lime or linden tree, which is used for making coarse kinds of ropes, and is used also for making the well-known bast mats from Russia and Sweden. Shoes worn by the Russian peasantry are also sometimes made from bast.

Raffia is familiarly known in this country as

florists' twine, and is employed for gardening purposes. It can be obtained from nearly all seed merchants or market gardeners at a moderate price; and it is sold, too, by the various educational supply houses. As raffia varies in quality, care should be taken to procure a good kind. In every skein or bundle there are strands of different thickness. Some of these are too thin for many purposes; but there need be very little waste if varied exercises with raffia are practised.

Because of its strength, softness, and pliability, raffia is an ideal material for construction work. It may be used by beginners with untrained fingers, or it can be adapted to the capacity of older children. Many charming and artistic articles can be made from this most adaptable of materials; but it must be remembered that the aim in raffia work, as in all handwork, is the development of the child, and not merely the rapid completion of models.

> "The things a child can make may small and worthless be;
> It is his impulse to create should gladden thee."

PREPARATION OF RAFFIA: WINDING (PLATES IA AND IB)

Before raffia is used, it is as well to damp it either in cold or warm water. It should then be shaken out, and partially allowed to dry. The strands should then be flattened out between the finger and thumb, or round a ruler or pencil. Some workers have been known to iron these strands, so as to obtain the desired effect of flatness and smoothness. This preparation is more necessary for the operations of winding, plaiting, and weaving, than when raffia is worked with a needle. The simplest raffia process is winding, an exercise that can be done by young children. In this exercise, the use of cardboard is combined with the use of raffia; and so the child is taught to compare the two materials, and to appreciate the differences between them.

Cardboards are prepared as outlines or skeletons of the objects to be made: shapes for frames, boxes, hats, wall pockets, or mats are cut out, and round these the raffia is wound, until the cardboard is covered. The ends of the strands must be carefully tucked in, to make them secure; and, in some cases, it is more satisfactory to stitch the ends down firmly. It is a good plan to separate carefully the bottom, sides, and lid of a pasteboard box, and to use the parts as foundations. When these are neatly covered with raffia, the parts are sewn together by an overseam stitch, to complete the model. Where spaces are made by winding the raffia on the round bases or lids, they may be filled in by darning with coloured raffia, or with pieces of

weaving. These models may be decorated with plaiting made either of natural-coloured, or of dyed, raffia. It is an excellent use to which to put the pieces of plaiting made during plaiting practice; and, in the arrangement of the ornamentation, elementary notions of design are practically instilled into the minds of the pupils. Another form of decoration might be added by means of a buttonhole stitch, worked round the edge with coloured raffia. Older children could assist in this work, and so encourage the spirit of co-operation. The models shown on Plates IA (facing p. 48) and IB are all easy of construction, and are worked by the process of winding. The bookmark (Plate IV) is also formed by winding; it has ash splints to form the spokes, but flat cane would also serve the purpose. The short spokes are crossed and fastened to the central long one, and round these strands of raffia are wound.

There are so many interesting possibilities in this use of raffia, that there is no lack of suggestions for models. In every case, the finished article should be for a definite purpose. The value of the frame is enhanced, when it is made for a picture of some favourite scene, or of some dear friend. Thus the child does his best, for he is working in obedience to the dictates of both heart and mind.

PLAITING OR BRAIDING (Plate II)

Plaiting or braiding may be taken as the next most simple operation with raffia, though at times it could be done by some of the children in a class, while others were busy with winding. Plaiting has always an interest for children. Little girls delight in a practice which enables them to have their hair neat and tidy. What a pleasure, too, to help with the toilet of a little sister!

The raffia must first be prepared in the same way as for winding; then several strands of the fibre are taken for each division of the plait, the number used being determined by the purpose for which the plaiting is intended. A plait of three divisions is the best to begin with, because tiny fingers cannot manipulate more. As the children become more dexterous at the work, broader plaits of four or five divisions may be attempted. When the strands get nearly used up, they are lengthened by fixing others into the plait without making knots. These additions are made gradually to keep the work even. When possible, children should stand while doing this exercise. Loops at the end of the strands to be plaited are fastened on small hooks fixed to any convenient wall space or to the side of a desk or work table.

The plaits are sewed to construct various

models, the thin strands of raffia being used for this purpose. Mats are made, either by sewing the plait at the edge or rolling it on its own width. The stitches must be neat and uniform. These mats are useful as teapot stands, or as stands for lamps or flower pots; and, if large enough, they make suitable cushions for garden seats. Other models made from plaiting have a fascinating interest for children. Belts made from the broad plaits, dolls' hats and dresses, baskets, cradles, cuff protectors, hatpin holders, and pincushions prove the value of teaching plaiting.

In making these models there is room for the expression of the individuality of the worker; and valuable opportunities occur for improving talks between the teacher and the pupils on subjects of general information. The hats of different nations, for example, suggest the various styles of dress and other characteristics of the people wearing them. The headgear of soldiers and sailors, at home, and in foreign countries, provides new ideas as to the purposes such headgear serves. Cradles vary in shape according to the nations using them. Baskets are suited to the purposes for which they are intended. By such channels of information the imaginations of the children are stimulated, and general knowledge of a varied and useful kind is imparted.

WEAVING (Plate III).

Weaving with raffia may follow the preceding exercises; but, if it be found more advantageous, it may be taken up before, or simultaneously with winding or plaiting; for weaving is, in itself, no more difficult than winding or plaiting.

For weaving, looms are required; and in the preparation of these the children may give assistance. The manual training is of much greater value if the looms are home-made. They may be constructed from odd pieces of stout cardboard; cut to a desired size. Holes are pierced or notches cut at opposite ends for the warp threads. Old slates may be used for the purpose, or wooden boxes of different sizes may be converted into looms. Small nails are fixed at opposite ends, and to these the warp threads are fastened. A shuttle is required, and a flat wooden needle expressly made for children's use in weaving can be purchased. Should these needles not be provided, good substitutes can be improvised from safety-pins or nails; or meshing needles may be made from pasteboard. Indeed, a small boy will generally produce from his pocket some implement to serve the purpose!

For variety, the warp threads may be of a contrasting colour to the woof, and patterns may be worked to form designs. These designs are suitable on the woven mats, as borders on dolls' skirts, or as patterns on bags. The mats may be

used as floor coverings in the doll's house, where they will be in keeping with the tiny pieces of furniture, also manufactured from raffia. Bags made of various sizes will be of service to the children for carrying books and lunches, and for other purposes. Wall pockets help to decorate the schoolroom wall, and are convenient as receptacles for letters and papers. From the smaller pieces of weaving, a needlecase or "housewife" can be readily made (Plate III).

At the expense of a little trouble, and by the exercise of some resource and ingenuity, many novelties can be made by using raffia in weaving. The practical acquisition of a knowledge of the process of weaving with raffia is educative, because it not only cultivates manual skill, but exemplifies the earlier stages of a universal industry; and it may be made more educative still, by showing how closely it resembles the processes yet in use among primitive peoples.

TOY MAKING (Plate IV)

From finished pieces of winding, plaiting, and weaving, toys are easily invented. Children delight in making their own playthings, and should be encouraged to use all odd scraps of material in the manufacture of them. Such toys as reins, whips, dolls' clothes, hoops, and small hammocks are made with great zest; and the making of them gives an added interest to the work.

Some of the examples seen in the plates are the results of the efforts of children in a typically country school, where handwork is made a speciality, and where it is taught, as it should be, in connection with the collateral subjects of instruction.

COIL WEAVING (Plate V)

The making of baskets with raffia, in imitation of Indian basketry, can be attempted by children old enough to perform the exercise of sewing with needle and cotton.

It has been the privilege of the writer to see many examples of the basketwork of the North American Indians. The symmetry of form and the wonderfully harmonious blending of colour lent an indescribable charm to those baskets. To the native worker, while she weaves with tireless fingers, her basket is an expression of her inner thoughts, and puts into shape and colour all that to her is symbolic of imagination and romance, of poetry and religion.

Most exquisite baskets are made with varieties of natural growths, such as are found by the Indians in the several districts in which they live. Beautiful grasses, corn husks, straw, split willow

and ash, cedar bark and roots, pine needles and sweet grasses, are all made use of by the workers in the construction of the Indian baskets, the material used being determined by its occurrence in the neighbourhood.

The native women, for it is they who are the basket makers, have much laborious preparation to make before the materials are ready for use. A comparison may be made between this preparation for basket weaving and that for the weaving done by the inhabitants of the North of Scotland, or the similar preparation made for their weaving by the peasants in many places in Norway.

The coil weave is the simplest beginning for raffia baskets. These are made by employing some of the stitches in use amongst primitive peoples. For this process the raffia need not be steeped; but, for the sewing, raffia strands of a good quality are necessary. The only tool required is a strong tapestry needle, which, in school work, takes the place of the bone awl used by the Indian workers.

Several strands of natural-coloured raffia are arranged to form a coil of the thickness desired for the model to be made. They must be neatly pared and put even at one end, where a coil is formed by sewing with a strand of dyed material. This beginning has the appearance of a flat coloured button, from which stitches are made at regular intervals by taking the thread over the coil, always held to the left, and putting the needle through the contiguous under-coil, to come out close to the preceding stitch. This gives the spiral effect seen in the models. The weave may be varied by altering the place of bringing out the needle, but the stitches must always be equidistant to form the spiral.

It is important that the coil be kept of equal thickness; and therefore, as the strands become thin, they must be replenished *without knotting* the raffia. When finishing off, the coil must be gradually tapered, and several stitches overlapped to make it secure. The shaping is done during the progress of the model, and the worker must know from the outset the exact pattern which it is intended should be reproduced.

So many novelties may be the outcome of this stitch, that the description of the objects it might be used in making would be endless. From Plate V it can be observed that great variety of form is arrived at; but, above all, the finished models ought to meet a required want. A child enjoys no greater pleasure than finding that his work has not only produced something, but something really useful as well. Like the Indian woman, his fingers will be attuned to the melodies and the harmonies of his thoughts, because he weaves with the knowledge, that his basket will be a precious gift for a loving mother or a valued friend. The child will give of his best, for he has pride and aspiration in his work; and he will be led to understand the nobility inherent in all useful labour.

"Not on the vulgar mass called 'work' must sentence pass."

STITCHES OF INDIAN BASKETRY (Plate VI)

The next stitches to be practised are those by which the coil or inner padding is completely covered by the sewing. The padding may consist of grasses, cord, or cane, and is prepared as for the spiral coil described above. If cane be used the end is sharpened and bent, after damping, to form a round for the centre. When a join is necessary, the cane must be spliced and the new piece dovetailed to the other in such a way as not to vary the thickness.

A short stitch is made by wrapping the raffia from the threaded needle round the coil, and then making a long stitch by bringing the needle through the space under the coil beneath. This long stitch secures the two coils. In pulling the raffia to make the stitches firm, to avoid shredding, the worker must take care to make the pull from the stitch, and not from the eye of the needle. When working a round base, extra short stitches are added as outlets to increase the size; or occasionally two long stitches may be made from the same place as increases.

Another form of the short-and-long stitch is known as the knot stitch. For this the same procedure is followed, with the addition of crossing the long stitch at right angles and bringing the thread round from the back to continue the short stitch. The knot stitch is a pretty variation, and may be introduced with other stitches in a basket, as ornamentation or for finishing the borders. Models made entirely of knot stitch look well. An example is the string case seen on Plate VI. The coil weave may be varied still further by taking the stitch from the top of the coil beneath, and keeping the stitches quite close together to cover the padding by the sewing. This is a favourite pattern with native workers, and it is frequently seen on specimens brought from abroad.

A very pleasing effect is produced when a variety of stitches is shown on one model. This is illustrated by the large open tray on Plate VI.

Of course these trays and baskets are beautiful because of the colour worked in as design. Each worker must decide on the pattern for the basket and the colours to be used, having, as guide to the right decision, the functional purpose of the completed model. Combinations of colour add to the beauty of the work; and every lover of true art will strive to introduce, in harmonious blending, several varieties of shades. These colours can be obtained by the simple operations used in dyeing the raffia at home or in school. It may not be possible for children to do the actual dyeing of the raffia; but their interest in the process of dyeing will be aroused, if they are asked to gather the blossoms, leaves, and roots from which the dyes are extracted. Nature's

storybook provides much suggestion for the work.

In all the models (Plate VI) in which coloured raffia has been used, the dyes have been obtained by the workers themselves, who had scant knowledge of the art of dyeing before making the experiments of which these are the results. It is not to be expected that children at school can make elaborate baskets, though good work of the kind is done in special schools by children who are unfit, physically or mentally, for the ordinary routine of lessons. This is another of the many proofs that handwork is an important factor in the development of the child.

DYEING

Actual experiment in the dyeing of materials is the best way of gaining the power to obtain desired results. Only vegetable dyes must be used, for they give true colours with soft, rich tones of shade, at variance with the crude, harsh colours obtained from aniline dyes. How elevating and satisfying are the sweet, delicate blendings of good colouring!

The old baskets, made by native workers, tell, in basket lore, of the time and patience spent in bringing to perfection the art of producing from natural growths the loveliest tones and tints. The results of the efforts of these uncivilized people may well be kept before us, as sources of inspiration helping to direct aright our present-day efforts.

Dyes may be extracted from familiar plants, and raffia is easily coloured by them. In nearly every case, a mordant is required to fix the dye. Alum and copperas are useful for this purpose, and are purchased cheaply at any chemist's. An enamel kettle is the best vessel to use when dyeing, and it is more convenient to have one specially made for the purpose. The following are useful shades, obtained from the sources named by experiment:—

Blue, from indigo, from blacberries with copperas, and from elder and broom with alum.

Red and *pink*, from cochineal, elder berries, alkanet root, beetroot, red and black currants, and damsons.

Green, from heather, leaves, holly berries, and ripe privet berries with salt.

Yellow, from bog myrtle, bracken root, St. John's wort, and saffron.

Purple, from logwood chips with alum and permanganate of potash.

Brown, from logwood chips and crotal (a lichen).

Black, from the bark of the alder tree; from meadow-sweet, and from water-flag root.

Far-reaching beneficial results may reasonably be looked for from experiments of this kind; because of the many lessons learned from Nature in following up the matter, and the many practical advantages that may be secured through a knowledge of the art of dyeing.

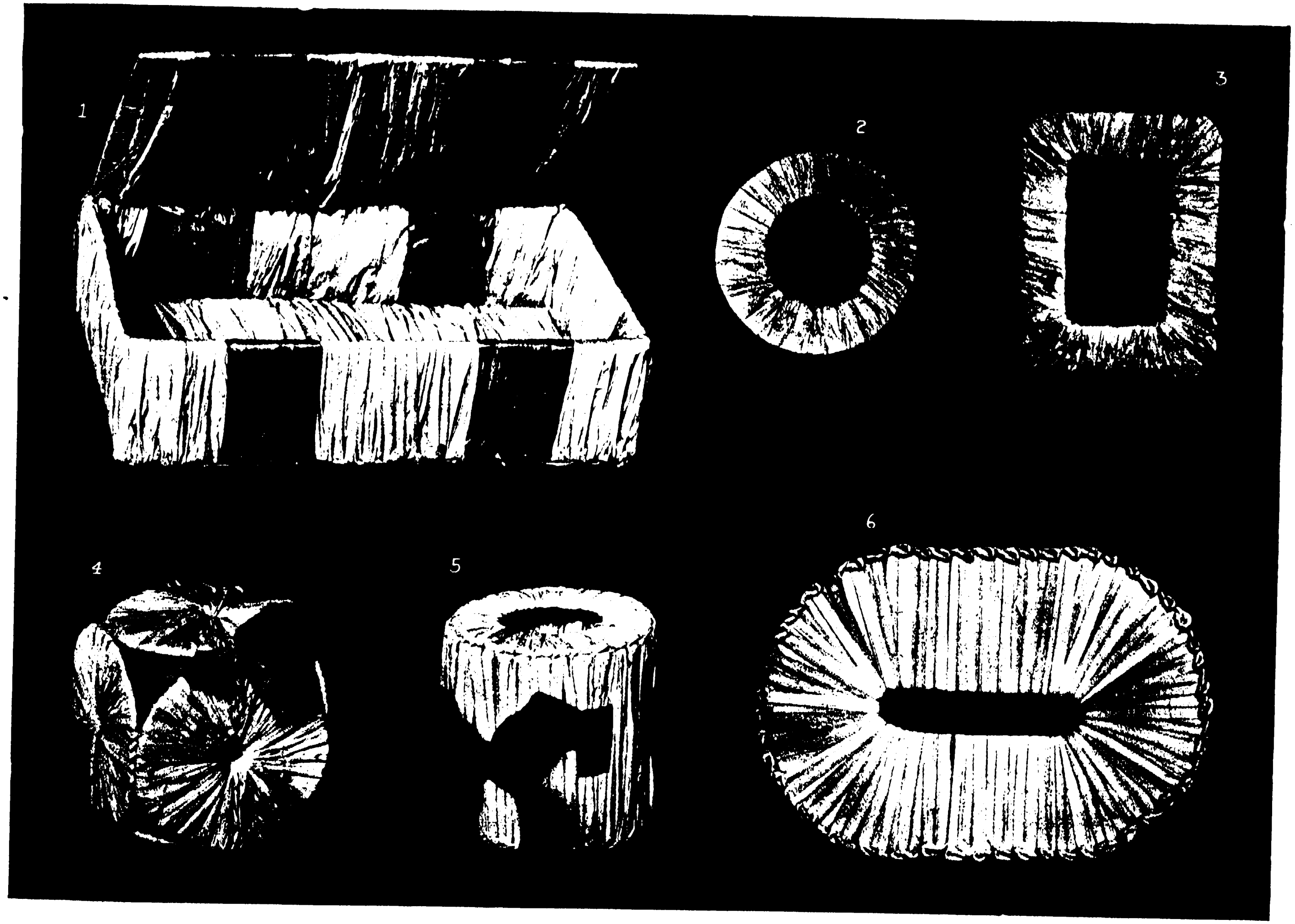
SEWING ON LINEN OR CANVAS WITH RAFFIA (PLATE VII)

The dyed raffia strands may further be put to use in sewing on linen and canvas. Odd pieces of linen are worked with simple designs, then stretched on cardboard and neatly lined at the back. These can be arranged for menu cards, calendars, or blotters. Linen may also be used for cushions, covers for chair backs, or small tablecovers, which look well, with the design sewed upon them with raffia of contrasting colours. With the use of canvas, beautiful articles are made. Designs are worked all over the canvas, which may then be converted into bags of different shapes, wall pockets, or stretched on lids of boxes. The bags require to be lined, not only to give them the needed strength, but in order, also, that they may have a neat appearance inside.

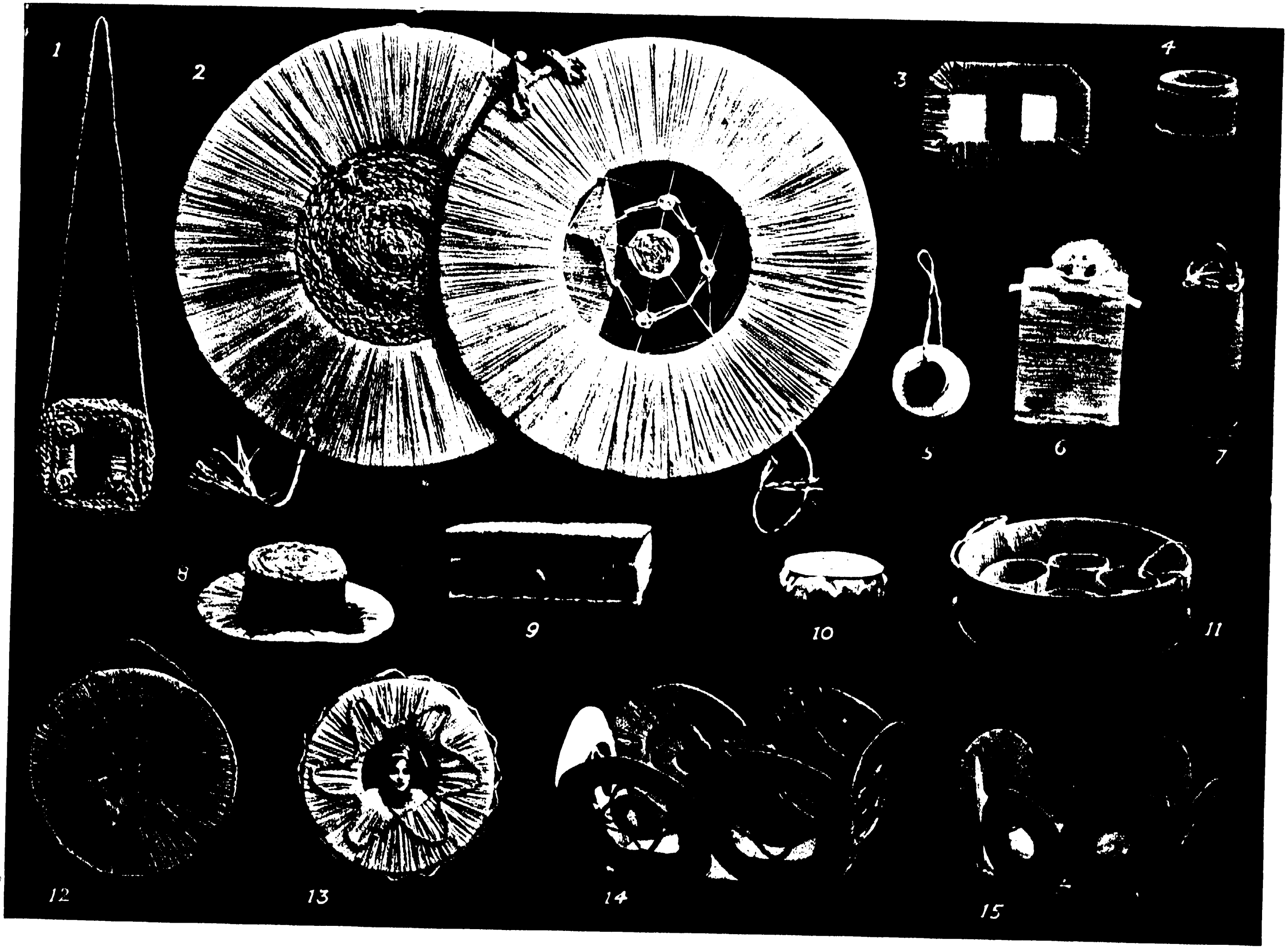
Raffia can also be used in hairpin work—table centre seen in Plate VII—and crochet work, by which useful decorative articles are quickly made.

Most pleasing effects are the result of this use for raffia, as may be observed from the finished models shown on plate.

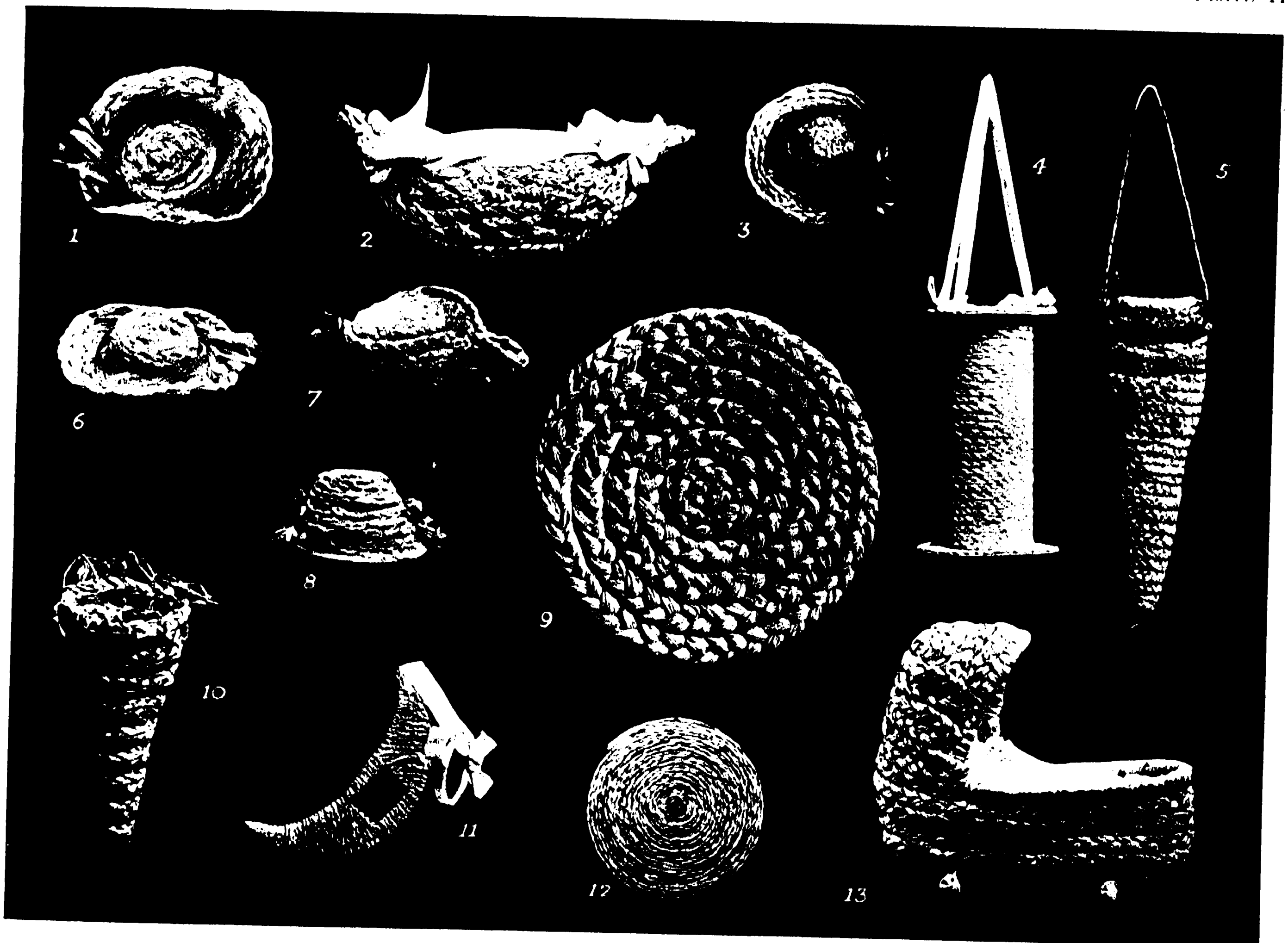
From what has been said, it is clear that raffia is a material with everything to recommend it, as a medium for use in educational handwork.



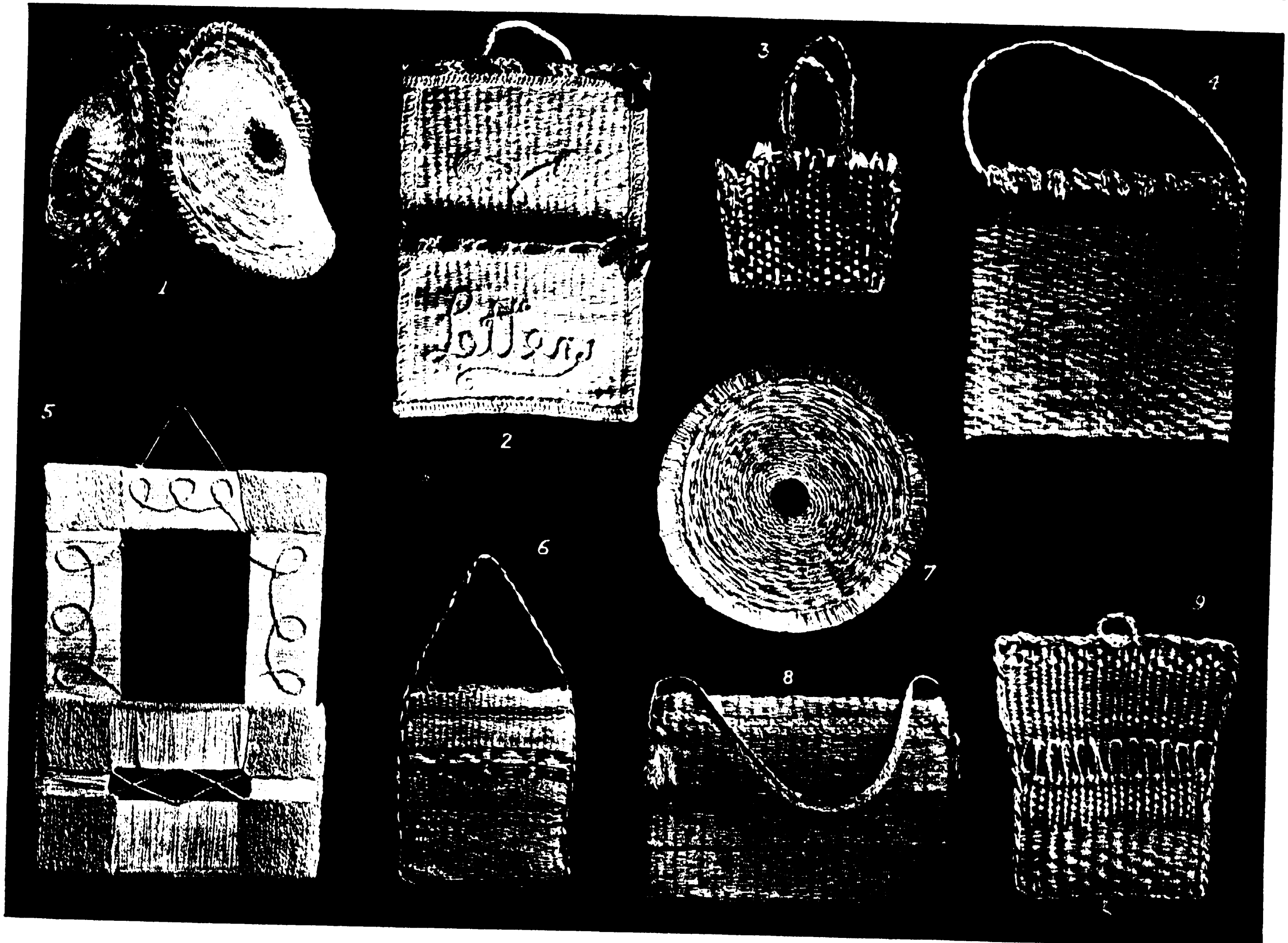
1. Box. 2. Mat. 3. Photo Frame. 4. String Case. 5. String Case. 6. Mat.



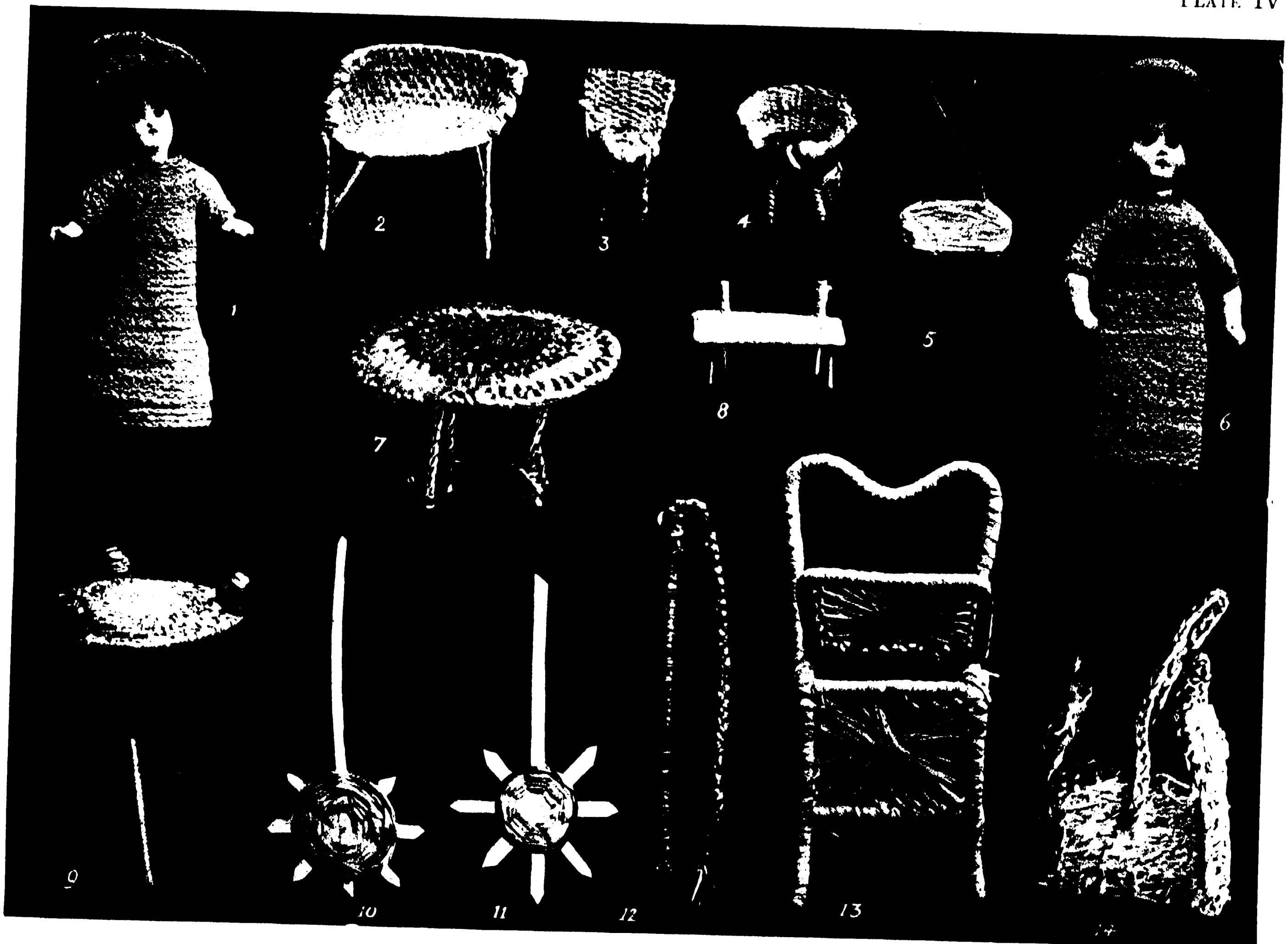
1. Photo Frame. 2. Doily Case. 3. Photo Frame. 4. Serviette Ring. 5. Pincushion. 6. Needle Case. 7. Taper Holder. 8. Doll's Hat. 9. Glove Box. 10. Pincushion. 11. Egg Stand. 12. Photo Frame. 13. Photo Frame. 14. Open Basket. 15. Open Basket.



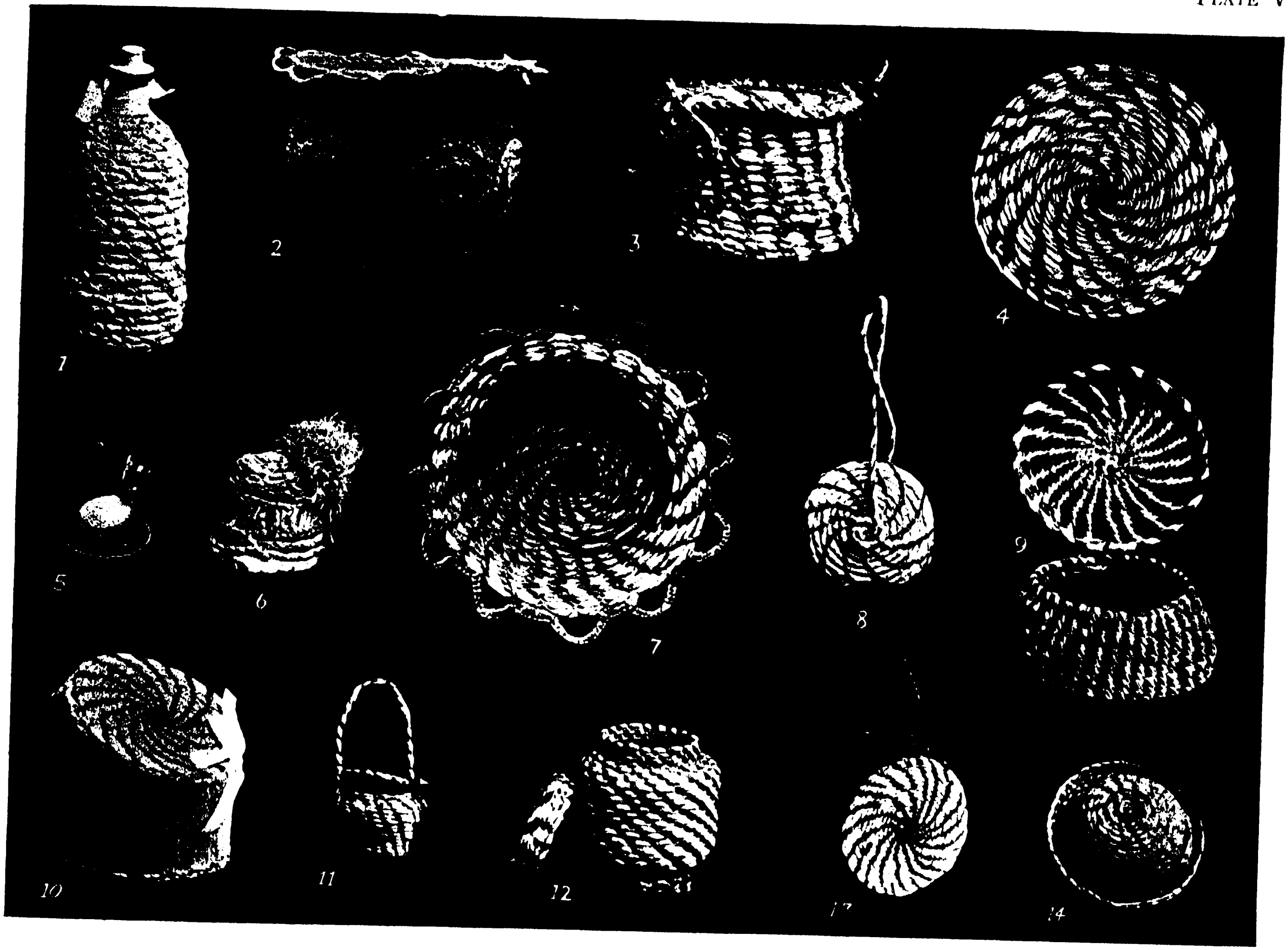
1. Doll's Hat. 2. Pincushion. 3. Doll's Hat. 4. Hatpin Holder. 5. Hatpin Holder. 6. Doll's Hat. 7. Doll's Hat. 8. Doll's Hat. 9. Mat. 10. Taper Holder. 11. Calendar Frame. 12. Mat. 13. Cradle.



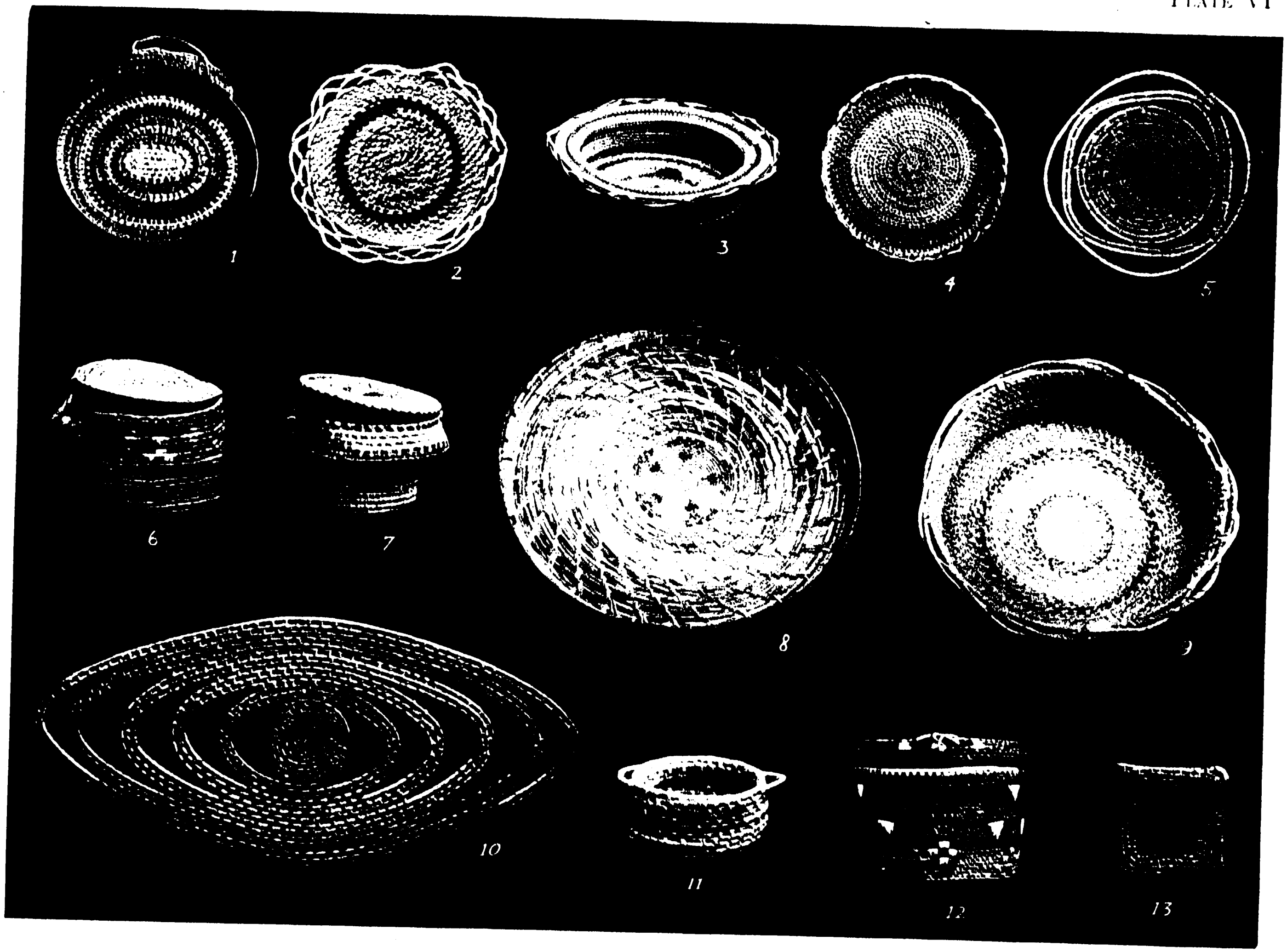
1. Flowerpot Cover. 2. Wallpocket. 3. Bag. 4. Bag. 5. Wallpocket. 6. Bag. 7. Mat. 8. Bag. 9. Wallpocket.



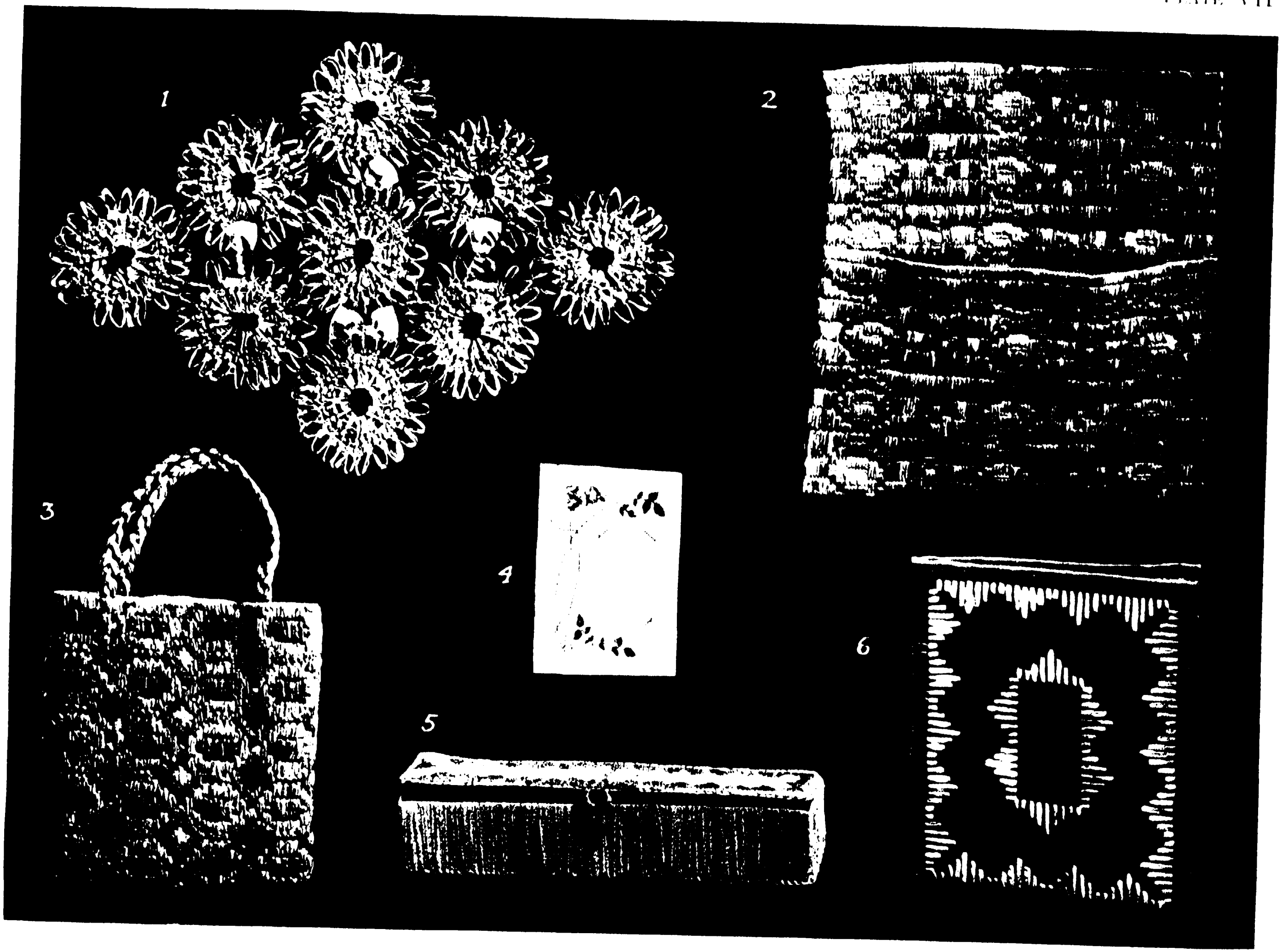
1. Doll's Dress and Hat. 2, 3, 4, 5. Chairs for Doll's House. 6. Doll's Dress and Hat. 7. Table for Doll's House. 8. Stool for Doll's House. 9. Table for Doll's House. 10, 11. Bookmarks. 12. Whip. 13. Chair for Doll's House. 14. Doll's Basket.



1. Scent Bottle Cover. 2. Flowerpot Cover. 3. Small Basket. 4. Mat. 5, 6. Dolls' Hats. 7. Card Tray. 8. Pincushion. 9, 10. Small Baskets. 11, 12. Trinket Baskets. 13. Pincushion. 14. Doll's Hat.



1. Card Tray. 2. Mat. 3. Small Card Tray. 4. Teapot Stand. 5. Mat. 6. Jewel Case. 7. String Case. 8, 9. Large Card Trays. 10. Dinner Mat. 11. Trinket Tray. 12. Work Basket. 13. Square Mat.



1. Tablecentre. 2. Wallpocket. 3. Bag. 4. Calendar. 5. Glove Box. 6. Blotter.

Educational Handwork

Junior Course

J. L. MARTIN
AND
C. V. MANLEY

This section deals essentially with "first principles", and forms not only a basis for an intelligent idea of the various mathematical processes, but an educational medium to the other subjects of the school curriculum. The exercises and models have been designed with the object of arousing the interest of the child, of training his powers of observation, and developing his instinctive and inherent tendencies to construct and manipulate material.

The teacher will not limit the lessons to those which are given in this course, but will encourage the pupils to measure various objects, and to construct models of these to a suitable scale. Rough working drawings should in all cases be made.

INTRODUCTION

A training based on Froebel's gifts and occupations such as is given in our Infants' Departments, and which aims at the development of a child's mind through its natural activities, is of the highest educational value. The child learns by doing. How unfortunate it is that this method is not continued throughout his career at school! The junior classes have, as a rule, no systematic form of hand-training, and this is a serious drawback in our educational system.

Sir James Crichton Browne, in a presidential address at the Salt School, Shipley, said:

The nascent or growth period of the hand-centres probably extends from the first year of life to the end of adolescence, its most active epoch being from the fourth to the fifteenth year, after which these centres, in the large majority of persons, become somewhat fixed and stubborn. Hence it can be understood that boys and girls whose hands have been altogether untrained up to the fifteenth year are practically incapable of high manual efficiency ever afterwards. We know that each brain-centre has its nascent period, which is sometimes short and sometimes long. But whether the nascent period be long or short, it is of paramount importance that it should be taken advantage of while it lasts, and that the organs related to the centre should be duly exercised during its continuance. If the nascent period is permitted to slip past unimproved, no subsequent labour or assiduity will compensate for the loss thus sustained.

In most towns, selected children are sent to Woodwork centres when they reach the higher classes; but, owing to the lack of motor training in the senior departments of our schools, they are generally unfitted to take full advantage of the course of instruction. It is the aim of this book to supply a scheme of work which will effectively deal with this break in our educational system, by providing such occupations as may be performed by the average child under ordinary conditions, and which will in addition provide a suitable scheme of Manual Training for Rural Schools. Too many handbooks deal with Manual Training as though it were a separate subject. It should, however, be treated as a "method" of training the activities of the child, in order to simplify the approach to such subjects as Arithmetic, Mensuration, Geometry, and Drawing.

The object of the teaching should be the development of the individual—the hand, eye, and brain being trained to work in harmony through the construction of suitable objects.

The materials required in the earlier stages are such as may be found in every school—brown paper, drawing paper (plain and squared), rulers, set squares, dividers, and scissors. For more advanced work, thin cardboard will take the place of paper, the knife being substituted for scissors.

Lesson Plan

Preferably a completed model made by the older children should be distributed to each pupil, in order that all may have the opportunity of discovering how it is made. Should this not be possible, however, two models should be exhibited—one a finished specimen, and the other fastened together by fix clips. The children discuss the shape, colour, &c., and then proceed to analyse. Measurements are taken, and this affords the teacher an opportunity of associating the work with arithmetic, mathematical drawing, &c.

If there are only two models, the plan must be drawn on the blackboard; but this is not necessary when all are supplied, as the measurements can be taken directly from the model.

As the class progresses, and the method of constructing the various figures has been learnt, the brighter children may be allowed to draw the outline directly on plain paper, instead of having material cut to the proper size given them. In this connection, however, it is well to *hasten slowly*.

In order that the colour sense may be trained, the pupils should be allowed to choose the shade of paper they prefer, and may also occasionally ornament their models by direct drawing with the brush or crayon. This gives an added interest to the work.

As much practice in measurement as is possible should be given, as it is of the greatest benefit to the children. They should be encouraged to bring dimensioned hand sketches of suitable models for construction. This develops *originality*, *initiative*, and *power*.

Diagrams

Kinds of Lines:—

Construction lines: thin

Cutting lines: thick

Folded lines: dash

Backward folds: dash and stroke

Materials required for Junior Course

Tools:—

Scissors, 4½*d*. per pair.

1 hollow plier punch, 1*s*. 10*d*.

Scoring nibs, 1*s*. per doz.; moistener, 9*d*. per doz.

Materials:—

Ordinary drawing paper, brown paper, and carton paper—6″ × 6″, 5″ × 5″, 4″ × 4″, at 6*d*., 5*d*., and 4*d*. per packet of 50 respectively.

Gummed coloured paper, 6″×6″, at 6*d*. per packet of 50.

Adhesive: Ducketts' Pastem at 6*d*. per packet; or, Le Page's liquid glue, 2*s*. per pint; or, Higgins' photo mounter, 4*s*. 6*d*. per doz. (The last is very clean and satisfactory.)

Paper fasteners (¼″), 4½*d*. per gross.

Total Cost for Class of 40:—

Tools - - £1, 1*s*.

Materials - 16*s*. (a yearly charge).

PART I

PAPER FOLDING AND CUTTING

1. Free Cutting.—The object of these exercises is to give facility in the use of scissors. Strict accuracy in cutting to a line will not be expected at first, as, of course, this can only come with practice. It will be well, therefore, to postpone the cutting of geometrical figures to a later stage. The following is a list of suitable objects for earlier lessons. They should be drawn either in mass or outline, and afterwards cut out with the scissors.

1. *Leaves:* dock, laurel, plane-tree, chestnut, &c.
2. *Fruits:* banana, apple, pear, tomato, cucumber, bean, pea-pod, orange, lemon.
3. *Vegetables:* turnip, carrot, onion, leek, potato, marrow, &c.
4. *Objects:* fans, shovel, spade, dust-pan, hand-brush, fork, saw, bellows, handglass, hatchet, bill-hook, meat-chopper, screwdriver, frying-pan, fish-slice, whitewash-brush, flag, feather, knife, trowel, wooden spoon, hat, racquet, bottle, signal-post, guide-post, notice-board, a fish, mallet, hammer, loaf, gate, ladder, Chinese lantern, Indian club, string of beads, &c.
5. *Animals:* chicken, mouse, rabbit, duck, swan, ostrich, parrot, &c.

2. Folding and Cutting Regular Figures.

Materials required: a 6-in. square of paper for each child, and a pair of scissors.

If the pupils have had no previous practice in paper folding, care should be taken that the correct method is used, as so much depends upon the right manipulation of the material in these preliminary exercises.

The paper to be folded should be placed flat on the desk, and the bottom edge should be turned to lie exactly on the upper edge.

The thumb of the left hand is placed firmly on the left side of the paper, whilst the extended fingers hold the two upper edges together. The right hand smooths the paper towards the line, and finally the crease is made by the right forefinger.

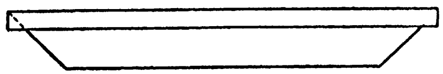
In cutting, the paper should be held firmly in the left hand, the thumb being on the upper surface. The *points* of the scissors should not be used in cutting. The whole length of the blades should be used.

EXERCISES

Ex. 1.—Fold the square across the diameter so as to show two oblongs. The children will readily see that this divides the square into two equal parts (halves). Let them cut along the diameter.

The name *oblong* or *rectangle* should be given. Show by folding that the opposite sides of the oblong are equal, and contrast with the square.

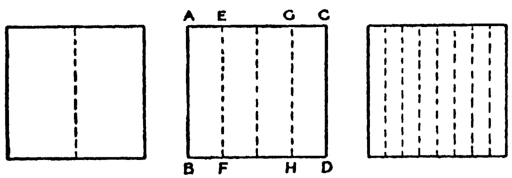
The two rectangles may be used in the construction of a paper boat.



Fold along the long diameter and turn down the corners as shown in the sketch.

Fold the edges outwards, and open the boat.

Ex. 2.—Fold a 6-in. square across its diameter. Open out, and fold the top and bottom edges to the centre, obtaining the lines EF and GH. Fold AB to GH, and CD to EF, AB to EF, CD to GH, so as to form eight rectangles.



Fold alternately backwards and forwards along these lines concertina-wise.

Fold across the middle to form a fan. (See Plate facing page 66.)

Ex. 3.—Fold a 6-in. square across the diagonal, thus showing that the adjacent sides are equal.

Cut along the diagonal. Give the term *triangle*.

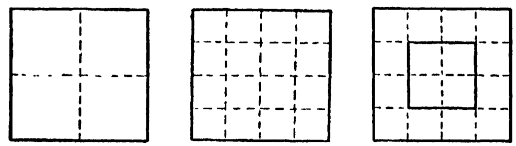
Call attention to the number of sides and angles.

Form similar triangles by folding and cutting the triangles already obtained.

Supplementary Exercises

Provide each child with three 8-in. squares.

Ex. 4.—(1) Fold one 8-in. square along the diameter. Fold the left edge to the opposite edge and crease.



(2) Fold the same square so as to show sixteen squares.

Ex. 5.—Fold another 8-in. square so as to show sixteen squarés. Open out and refold along the diameter.

Cut out the four central squares as shown in the diagram.

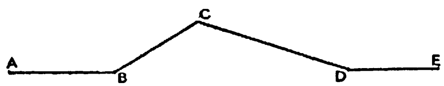
The third square may be placed at the back, so as to complete the frame. (Pupils may be allowed to paste the best specimens on three sides.)

These exercises provide excellent practice in cutting to a line, and the pupils will have found the necessity for considerable care. In these early lessons no attempt at definition should be made, but in order to avoid looseness of expression and to facilitate the progress of the work, it will be necessary for the teacher to see that the pupils have "general notions" of what is meant by the various geometrical terms as they arise.

A Lesson on Lines

Materials required: drawing paper, pencils, rulers, 6-in. square.

1. Practice should be given in joining points at varying distances apart, first without the aid of a ruler. The points should be lettered.



2. Fold a square across its diameter, and place the line so formed between two points. Show that the edge of the fold is *straight.*

Ask the pupils to compare their freehand lines with this edge. These will mostly be *crooked* lines.

Which line is shorter when two points are joined—the straight line or the crooked line?

3. Place two points on the paper, and ask the children to suggest a method of joining them so as to form a straight line by using their folded paper. Have several points joined in this way.

It will be seen that a folded paper is not a satisfactory instrument to use to obtain straight lines, and rulers should be provided and practice given in joining points.

The correct method of holding the ruler should be pointed out.

A B

In joining A to B the pencil should be placed on the point A, and the ruler should be brought up to the pencil and then turned so as to allow of the pencil passing exactly through B.

Considerable practice will be necessary before this can be done correctly.

4. Draw several lines with the pencil touching the lower edge of the ruler (i.e. the edge nearer the pupil), and others along the edge farther away.

Which is the proper method?

5. The teacher should now take a cardboard circle and fasten a piece of red tape tightly across it.

What sort of line does the tape form?

Call attention to the two points of the circumference.

Let a child place his ruler on the first point and turn it along the circumference to the other point.

How does this line differ from the straight line? the crooked line?

Give the name *curved* line, and note again that the straight line is the shortest distance between the points.

6. Fold the square along its diameter.

Refold in another direction. Make a dot where the two lines cross.

Repeat this several times until the children notice that *two lines cross at a point.*

N.B.—A point is best indicated by a cross thus **X**, and should always be shown in this manner.

Measurement of Length

Materials required: drawing pins, tape, rulers, pencils, drawing paper.

1. Fix two drawing pins to the blackboard and call them A and B.

At A fasten one end of a thin piece of tape, and allow it to hang loosely from A to B, where it is again fastened.

Pull the tape taut from A towards B, and show the children that the portion between A and B is shorter than before.

Cut the tape when it is strained between A and B and fastened at the points, and by placing the ruler along the bottom edge test whether it forms a straight line.

2. Let the children draw several straight lines, using their rulers, and call their attention to differences in length, so as to establish the need of a unit.

We might use the first joint of the thumb or the width of a finger.

The children will readily give reasons why such standards would be unsatisfactory.

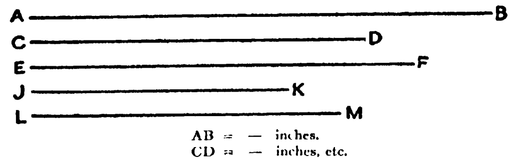
Rulers showing inches, halves, and quarters should be distributed, and the meanings of the various marks be shown.

Lines of 2″, 3″, &c., should be drawn, and the need for care shown.

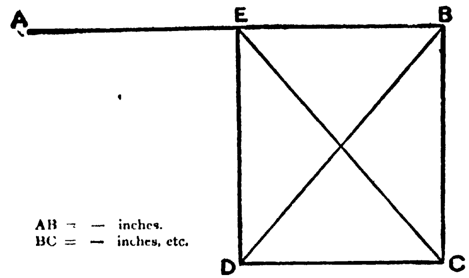
3. The teacher should hectograph a few examples of lines an exact number of inches in length, and use them for practice in measurement; and should require the children to make written statements as to their length.

EXERCISES

Ex. 1.—Measure each line.



Ex. 2.—Use your rulers and find the lengths of AB, BC, CD, AE, BD, and CE.



Questions on Ex. 1.—

How much longer is AB than JK? What is the difference between LM and EF?

What must be added to LM to make AB?

What is the length of a long line equal to AB, CD, and EF?

From CD + JK take AB.

From EF + LM take CD.

AB + EF − CD − JK − LM.

What is the difference in length between the two longest lines added together and the two shortest lines?

Questions on Ex. 2.—

What is the total length of the sides of the flag?

What is the difference in length between one short side and one long side?

What is the difference in length between two short sides and two long sides?

How much is the length of all the sides greater than CE + BD?

How much is CE shorter than CD + DE?

What is the total length of CB, BD, and DC?

How much is BD shorter than two long sides?

Ex. 3.—Draw a line longer than 8″.

Mark a point near one end and carefully measure 8″.

Mark a point 5″ back. How long is the remainder? Measure.

Ex. 4.—Draw a line 3″ long. Add another line 6″ long to it. Measure the complete length.

$$3'' + 6'' = 9''$$
$$9'' - 3'' = 6''$$
$$9'' - 6'' = 3''.$$

Ex. 5.—(*a*) Use the plain side of your ruler and draw a line. How long do you think it is?

Now measure it and see how much you are in error?

(*b*) Try to draw lines in this way 7″, 3″, 5″ long.

Practice should now be given in estimating and measuring the dimensions of various common objects. The lengths of several should be ***known***, as it is of great importance that the pupils should have a mental ***image*** as a basis for ***comparison***.

The following are suggestive: books, slates, a new lead pencil, picture cards, postcards, &c.

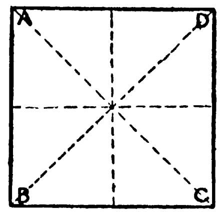
The perimeters should be found.

The Square

Materials required: squares of carton paper (4 in.), rulers, set-squares, scissors.

To show the Equality of the Sides and Angles.—Measure the sides, using the ruler.

Letter the angles ABCD and fold as in sketch.



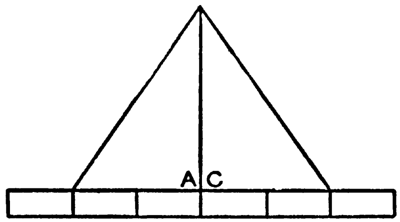
1. Fold along the diameter to show (*a*) that side BC = AD; (*b*) that angle at A = angle at B and that angle at C = angle at D.

2. Open and then fold along the other diameter to show the equality of sides AB and DC and angles A to D and B to C.

3. Fold diagonally to show that angle B = angle D, and similarly show that angle C = angle A.

4. By folding show that either of the four angles is equal to each of the others.

The Right Angle.—1. Divide the square through one of its diagonals forming two triangles. Cut out the triangles and place in the position indicated.



Call attention to the fact that when the equal angles at A and C are placed together in this way the two bases form a straight line. Prove by using the ruler.

2. Let the children find by experiment that no other two *equal* angles when placed in this way on the ruler form a straight line.

Note.—Equal angles may be made by folding any piece of paper and cutting through the fold.

The name *right angle* should now be given, and the right angle of the triangle cut out by the pupils should be used as a standard of measurement.

The angles of various objects, as books, picture frames, the easel, cube, block, &c., should be tested, and statements be made as to whether these angles are equal to, less than, or greater than, a right angle.

The Set-Square.—Distribute set-squares (45°) and show the similarity to the triangle under consideration, and also its greater suitability for the construction of right angles.

EXERCISES

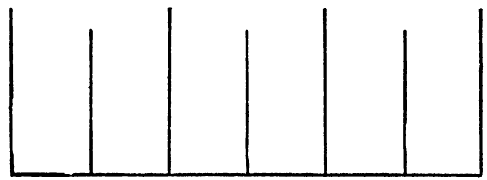
Ex. 1.—Make a right angle by drawing round the set-square.

Ex. 2.—Place the ruler on the paper and draw a line 6″ long.

Holding the ruler in position with the right hand slide the set-square along it with the left. Carefully bring the set-square to rest opposite each inch mark.

When this can be done without moving the ruler perpendicular lines may be drawn from each inch mark.

In order to free the right hand to use the pencil the ruler should be held by the thumb and forefinger of the left hand and the set-square by the other three fingers. The right hand must hold the ruler while the left hand moves the set-square. When the set-square is in position the ruler is held by the thumb and forefinger as before. The right hand should not be raised from the ruler till the finger and thumb of the left hand are in position.



The Square Inch

Materials required: carton paper, 4-in. square, box of square-inch tablets, pencil and ruler, drawing paper.

1. Measure each side of the tablet.

2. Lay the tablet on the drawing paper. How much space is covered by it?

Draw round the tablet.

A space is enclosed equal to one *square inch*.

Explain that this is how *spaces* are measured, and contrast with the measurement of length. A new unit is required for space or surface.

Ask the children to measure the space or area of the 4-in. square using their inch tablets. How many are required? The square is said to contain 16 sq. in.

The senior children should cut out rectangular figures of various dimensions containing an exact number of square inches, e.g. 1″ by 4″, 2″ by 4″, 3″ by 4″, &c., and the junior classes should find the areas of these figures by using their tablets as indicated.

Paper Cutting and Designing

Each child should be provided with a 6-in. square gummed at the back.

The square is examined first in its upright position as in fig. A, and then slanting as in fig. B, and the terms *vertical, horizontal,* and *oblique* are taught with reference to the position of the lines. (See page 60.)

The square may be folded and cut so as to form four smaller squares, and, again, so as to form eight triangles. These squares and triangles should be cut out and superimposed on white or tinted paper to form numerous designs. The inventiveness of the child shows itself in the formation of interesting and original patterns. A suitable moistener should be provided.

Questions should be asked as to the lengths of lines, number of edges, corners, triangles, &c. E.g. see fig. G.

How many angles are there in the inner square?

How many triangles in all the squares?

How many oblique edges are there?

What is their total length?

Count the vertical edges. What is their total length?

Find the perimeter of each of the squares.

It will considerably improve the appearance of the designs if the joining lines are lined in with a soft pencil.

The direct construction of designs using ruler and set-square should now follow. The patterns should be drawn on the gummed paper and cut out and superimposed as on page 60 and the accompanying plate.

The Rectangle

Materials required: Two 6-in. squares of paper for each child, pencils and rulers, set-squares, plain paper.

1. Fold a square across its diameter.

Cut along the fold making two oblongs.

Measure the opposite edges.

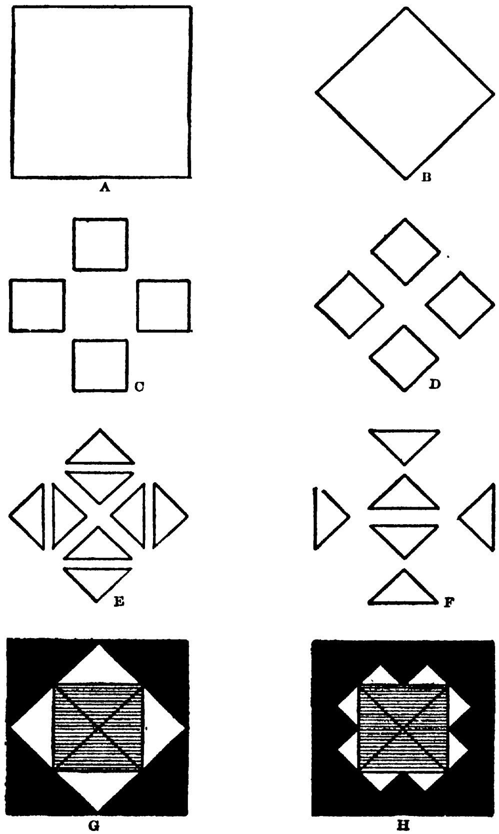
Test the angles with the set-square.

How many square inches are there in each part?

What can you say about the two long sides? the two short sides?

Make a statement about the angles.

2. Carefully divide each side of the other 6-in. square into inches.



Paper Cutting and Designing

Join all opposite points. What do you notice about each of the divisions?

How many square inches are there in the first row?

How many square inches are there in two rows? in three rows? &c.

How many square inches are there altogether?

3. (*a*) Using your square inches build a rectangle having its long sides 5 in. and its short sides 4 in. long. How many square inches does it contain?

(*b*) Take 21 squares. Use them to build a rectangle with the short sides 3 in. long. What is the length of the other sides? What is the perimeter?

(*c*) Use 24 squares to build a rectangle with its short sides 3 in. long. Find length of other sides and the perimeter.

Use 24 squares to build a rectangle with its long sides 6 in. How long is the short side? What is the perimeter?

Try to make any other rectangle with 24 squares. How long are its sides? What is the perimeter?

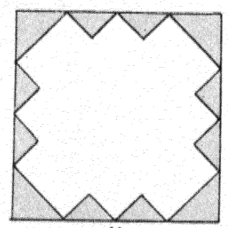
(*d*) Use all the squares and build rectangles with short sides of 2 in., 3 in., 4 in., 5 in.

How many square inches are left when the short side is 5 in. long?

How many square inches remain when you build a rectangle with its long edges 8 in.? 10 in.?

4. Let the children construct rectangles of various dimensions using their rulers and set-squares 5″ by 4″, 5″ by 3″, 5″ by 2″, and 5″ by 1″, &c. In each case statements should be required as to perimeters and areas.

5. The diagonals may be drawn and the parts cut



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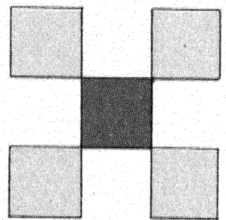

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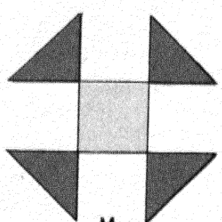

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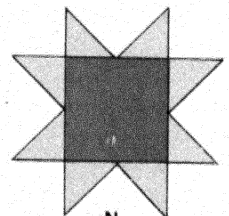

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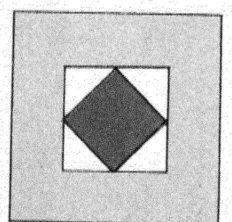

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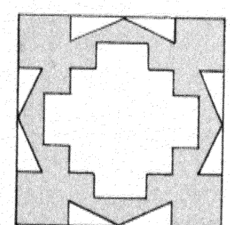

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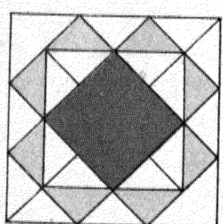

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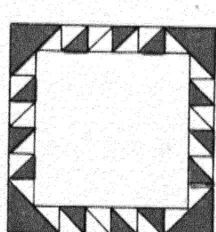

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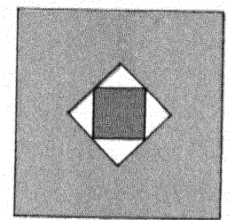

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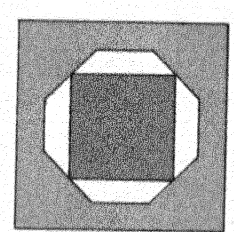

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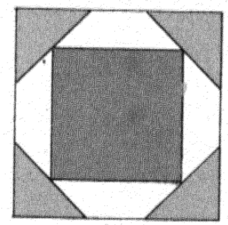

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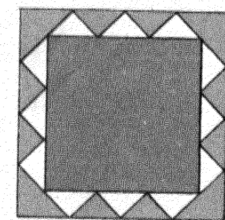

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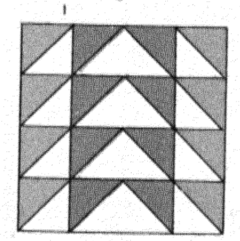

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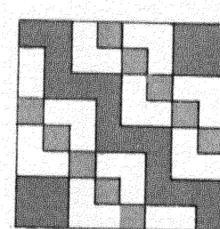

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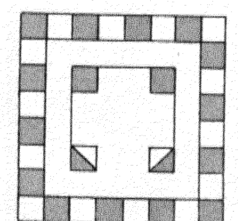

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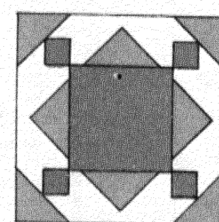


Z

out. These may be placed over each other and the area of the triangle found.

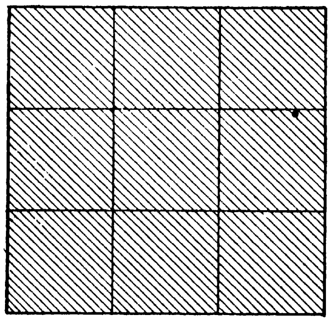
Exercises in Comparison

Squared paper ruled in inches should be provided.

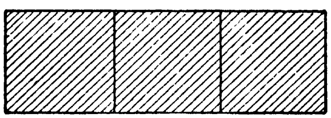
Ex. 1.—Colour a 2-in. square. Compare it with 2 sq. in. Make a statement.

A 2-in. square is —— square inches more than 2 sq. in.

Ex. 2.—Colour a 3-in. square. Compare it with 3 sq. in.



A 3″ square contains 9 square inches



3 square inches

Ex. 3.—Colour a 4-in. square. Compare it with 4 sq. in.

Ex. 4.—Colour a rectangle 4″ by 2″. Compare it with a 2″ square.

Ex. 5.—Colour a rectangle 6″ by 3″. Compare it with a 2″ square.

Ex. 6.—Compare a rectangle 9″ by 6″ with a 3″ square.

Ex. 7.—Compare a rectangle 2″ by 4″ with a 4″ square.

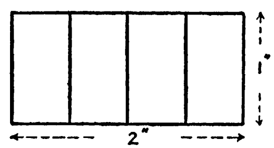
Ex. 8.—Compare a rectangle 9″ by 3″ with a 3″ square.

Perimeters, &c., should be found.

The Half Inch

Apparatus: drawing paper, pencils, rulers, and paper strips 2″ by 1″ and 6″ by 1″. (These should have been prepared by senior children.)

Thin cards, preferably in various colours in order to facilitate reference, $2\frac{1}{2}'' \times 3\frac{1}{2}''$, $3\frac{1}{2}'' \times 4\frac{1}{2}''$, $3\frac{1}{2}'' \times 5\frac{1}{2}''$; a square $4\frac{1}{2}''$.



1. Fold the oblong 2 in. by 1 in. into four equal parts.

Measure each part.

Compare the length with the inch.

2. Using the ruler mark the strip 6 in. by 1 in. showing inches and half inches.

Use this paper scale for measuring lengths of lines.

3. (*a*) The dimensioned cards should now be examined, measured, and drawn full-size from the measurements obtained using ruler and set-square.

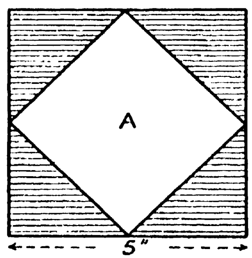
The teacher will question the class as to the length of all the sides of the figures, &c.

(*b*) The various drawings should be cut out and compared with the dimensioned cards by superimposition.

(*c*) Draw and cut out a square 5 in. side.

Mark the centre of each side.

Join the centres.



Cut out the figure A. Test if a square.

Place the shaded parts together so as to form another square.

Compare the two squares.

What is the area of the outer square?

If we call the large square "one", what would square A be?

What then is the area of square A?

If each triangle is called "one", what would square A be?

What part is one triangle of square A? Of the large square? What is $\frac{1}{8}$ of 24? 32? 40?

How many eighths equal one half? one quarter? three quarters?

Find $\frac{3}{8}$ of 16? 24? 32? 40? 48?

Find $\frac{5}{8}$ of 16? 32? 40? 48?

(*d*) Draw a line 3 in. long, and mark the half inches. What is the half of 3 in.?

$$1\tfrac{1}{2}'' + 1\tfrac{1}{2}'' = x \text{ in.}$$

(*e*) Join two lines each $2\frac{1}{2}$ in. long. Measure the joined line.

$$\tfrac{1}{2} \text{ of } 5 \text{ in.} = x \text{ in.}; \; 5 \text{ in.} - 2\tfrac{1}{2} \text{ in.} = x \text{ in.}$$

(*f*) Draw a line 7 in. long, and from one end measure back $3\frac{1}{2}$ in. Measure the remainder.

$$\tfrac{1}{2} \text{ of } 7 \text{ in.} = x \text{ in.}$$
$$3\tfrac{1}{2} \text{ in.} + 3\tfrac{1}{2} \text{ in.} = x \text{ in.}$$
$$7 \text{ in.} - 3\tfrac{1}{2} \text{ in.} = x \text{ in.}$$

(*g*) Cut out squares with side $2\frac{1}{2}$ in.; with side 5 in. Find how often the smaller is contained in the larger.

The Quarter Inch

(This exercise may be deferred until model 9, page 75, is constructed.)

Cut a narrow strip of paper 1" long, and fold it into two half inches. Fold each half again. Cut through the folds and examine the various sections with the scale ruler.

Cut a strip of paper 3 in. long. Fold and cut in halves. Measure.

Refold each half and cut. Measure. How much less than 1"?

How many ¾ in. make 1½ in.?

¾ in. × 2 = x in.; ¾ in. × 4 = x in.

Draw a line 4¼ in. long. Mark 3 in. back from one end. Measure the remainder. How many ¼ inches are there in it?

Draw a line 5 in. long. Mark the centre. See how often a paper strip 1¼ in. long will measure this line.

Draw a line 1¼ in. long and place another to join it 2¾ in. Measure the whole line.

Examine your ruler and find how long a line would be if its parts were ¾", 1¼", 1½".

Discover the results of the following by drawing, folding, &c.:—

1¾ in. × 2 = x in. 2¼ in. ÷ 3 = x in.
3¼ in. − 2½ in. = x in. 4½ in. ÷ 6 = x in.

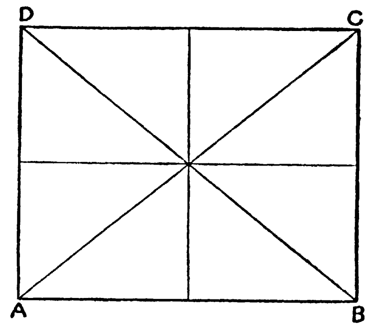
Measure lengths and widths of cards, books, pencils, &c.

The Oblong or Rectangle

Apparatus required: Drawing paper, pencils, rulers, scissors.

EXERCISES

Ex. 1.—Construct a rectangle 3 in. by 2¼ in.



Let children examine the figure and elicit that it has (*a*) four sides; (*b*) four angles (all right angles); (*c*) opposite sides equal.

Ex. 2.—Join AC and BD. Measure the length of each. (*Diagonals.*)

AC = — inches; BD = — inches.

The diagonals are equal. Test other rectangles.

Find the length of AD + DC + AC.

How much longer is the diagonal AC than AD + DC?

Ex. 3.—Fold AB to DC and then open and draw the *long diameter.*

Ex. 4.—Fold AD to BC and then draw the *short diameter.*

Ex. 5.—Measure and find which is longer and by how much:—(*a*) Diagonal or short side; (*b*) diagonal

or long side; (*c*) diagonal or two sides; (*d*) diagonal or short diameter; (*e*) diagonal or long diameter; (*f*) two diagonals or two diameters; (*g*) two diagonals or perimeter.

Ex. 6.—Cut across AC and compare the size of triangles by superimposition.

Ex. 7. Compare the various angles, i.e. ADC and CBA, DCA and CAD, DAC and BCA.

Angles and Triangles

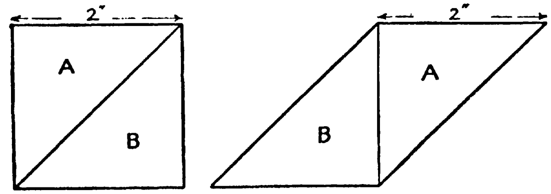
Meaning of the Term Angle.—This can be well explained by reference to the blades of the scissors or the teacher's compass. The idea of rotation as causing a change of direction needs considerable illustration, as it is difficult for a child to grasp.

Use the model clock face. Start with the hands at 12, and turn the small hand to 2, 4, and 5. The children will readily see that the small hand must be turned more to show 4 o'clock than 2 o'clock, and more still for 5 o'clock; thus they will understand the angle as the amount of turning necessary to indicate the difference in direction of two lines which meet.

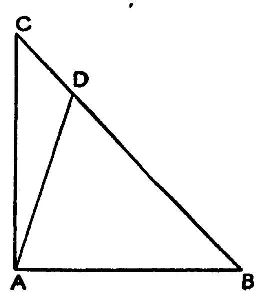
The *right angle* should be used as a standard for comparison as has been indicated before, and the names *acute* angle and *obtuse* angle given.

EXERCISES

Ex. 1.—Draw a *right-angled* triangle having a base of 2¾ in. and a height of 3 in.



In the side AB take any point D. Join AD. Compare the angles CAB and DAB. Note the acute angle. Cut out the triangle DAB. Test all the angles and give the name *acute-angled triangle*.



Ex. 2.—Fold a 4-in. square on a diagonal.

Cut through the diagonal and arrange as above.

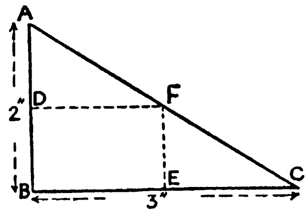
Note the obtuse angles at C and D.

Compare the areas of the two figures.

Ex. 3.—Examine the set-square. Ask children to point out the right angle. Measure each of the sides. Repeat, using other right-angled triangles.

Elicit the position of the longest side with reference to the right angle.

Ex. 4.—Draw a right-angled triangle, having base 3 in. and height 2 in.

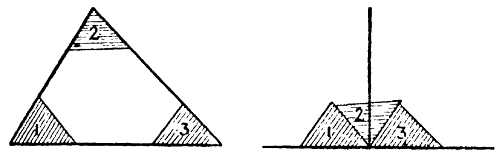


Fold as indicated in the diagram.

Compare the sum of the two angles BAC and ACB with the right angle.

Repeat, using other right-angled triangles.

Ex. 5.—Draw any triangle ABC. Draw two right angles touching each other as below.

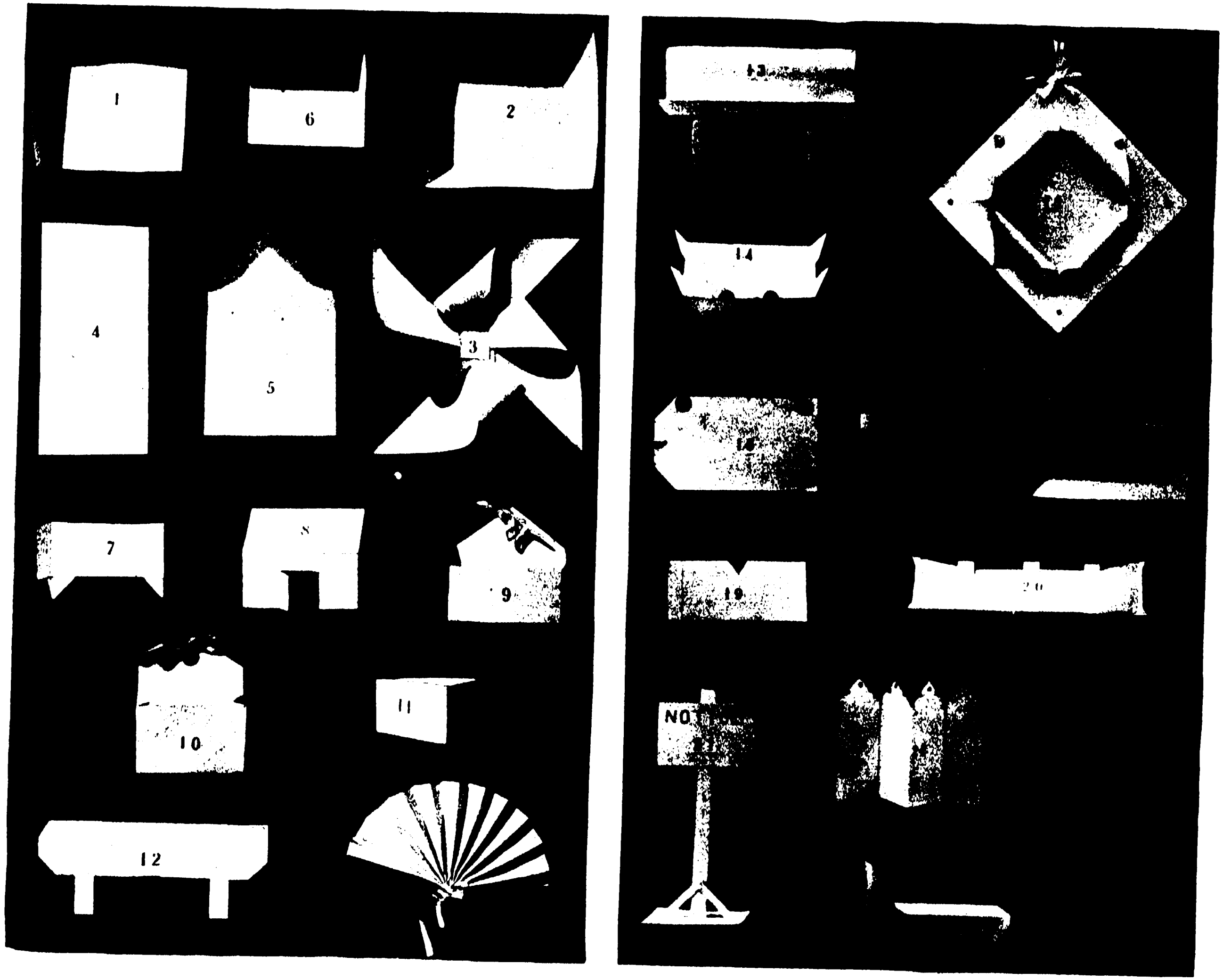


Cut the triangle as indicated.

Place the three portions cut out resting on AB and meeting at D.

Compare the size of the two right angles and the other three angles.

MODELS FOR JUNIOR COURSE



1, Square Tray (Rectangular Sides). 2, Square Tray (Sloping Sides). 3, Windmill. 4, Paper Bag. 5, Square Envelope. 6, Trough. 7, Trough (with Legs). 8, Barn. 9, Wall Pocket (Straight Edges). 10, Wall Pocket (Folding Edges). 11, Triangular Trough. 12, Stool. [illegible] Fan. 13, Garden Seat. 14, Washing Tub. 15, Photograph Frame. 16, Luggage Label. 17, Oblong Box (Rectangular Sides). 18, Oblong Tray (Sloping Sides). 19, Comb Case. 20, Punt. 21, Notice Board. 22, Screen. 23, Fire Shovel. 24, Sledge.

PART II

1. Square Tray

(Rectangular Sides)

CONSTRUCTION.

Cut along the lines as indicated; fold on the dotted lines. Gum the flaps and fix inside.

EXERCISES.

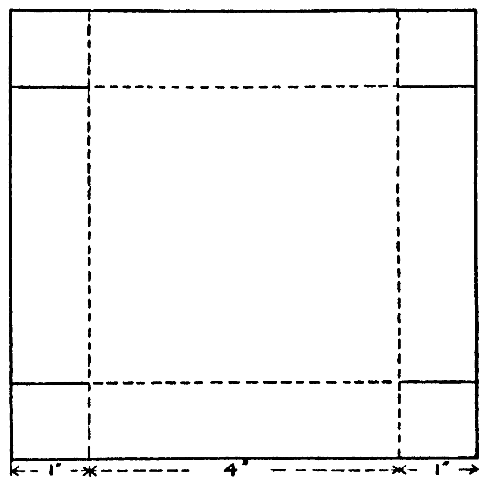
How many rectangles are there in the drawing?
Find the area of each.
Find area of the bottom of the tray.
Examine each of the flaps. Test if each is a square.
Find the area of one flap; of all the flaps.
What was the area of the large square?

$$16 \text{ sq. in.} - 4 \text{ sq. in.} = x.$$

Find the total area of the bottom of the tray and the four flaps.
How would you find the area of all the rectangles?
If we call the large square "one", what would the rectangles be?
What would be the sum of the small squares?
What would the bottom of the tray equal?

APPLICATION.

This exercise should be followed by a free attempt on the part of the pupils to make a lid to fit the box.



2. Square Tray

(Sloping Sides)

CONSTRUCTION.

Fold along the lines indicated. In this case, however, the flaps should be fastened outside, this being the least conspicuous position.

EXERCISES.

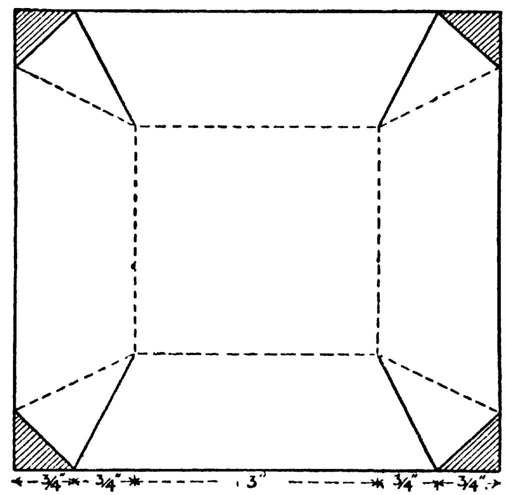
Measure the sides of the paper given.
How many angles? What is the area?
Use the cut-off corners to form a square.
Find its area.
Form *two* squares with the same four pieces.
Measure the perimeter of the top edge of the completed model. How much is it longer than that of the bottom edge?

$$\tfrac{1}{2} \text{ of } 1\tfrac{1}{2} \text{ in.} = x \text{ in.};$$
$$\tfrac{1}{4} \text{ in.} \times 4 = x \text{ in.};$$
$$\tfrac{3}{4} \text{ in.} \times 4 = x \text{ in.}$$

APPLICATION.

At the close of the lesson the collected models should be fitted each inside the other, showing how articles of this construction (similar figures) may be packed in a small compass. Ask for examples. Show the superiority of this shape over that of objects of rectangular form for purpose of storage, e.g. baking tins, zinc pails, baths, &c.

It is suggested that the next exercise should be the construction of a model of a bread-baking tin, half full size, the pupils to take the measurements to the nearest inch from the actual object.



3. Windmill

CONSTRUCTION.

The inch square of stout cardboard is distributed to the class, and suggestions are invited as to the best method of fixing it in the centre.

The square is firmly glued as shown.

The diagonals are then cut to the edge of the cardboard.

The corners A, B, C, D are turned over and glued to the centre.

A pin is then pressed through the centre into the end of a stick.

EXERCISES.

What is the length of one side of the square? of the four sides?

What is the area of the large square?

How many angles are there before cutting out?

Use your set-square and test each of the angles in the centre. How many right angles are there?

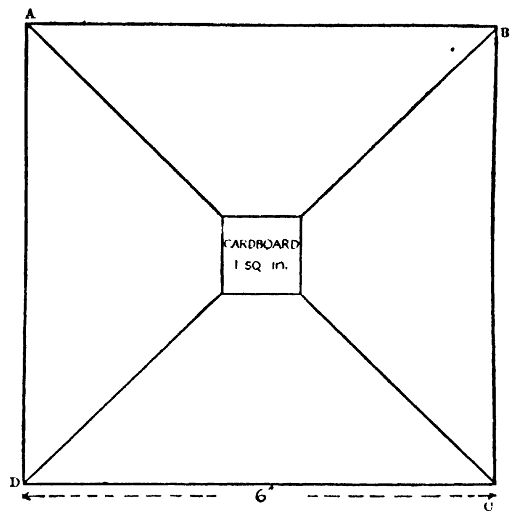
After fixing the central square, find how many angles are greater than a right angle.

What is the difference in area between the whole square and the central square?

What is the area of each of the four equal divisions of the remaining portion? $\frac{1}{2}$ of 24? $\frac{3}{4}$ of 24?

APPLICATION.

The windmills may be suspended in various positions in the room to show air motion, e.g. (*a*) over the ventilator—note the velocity; (*b*) over the radiator or stove—note upward ascent of heated air.



4. Paper Bag

CONSTRUCTION.

Cut out the waste.
Fold and gum the side and then the bottom.

EXERCISES.

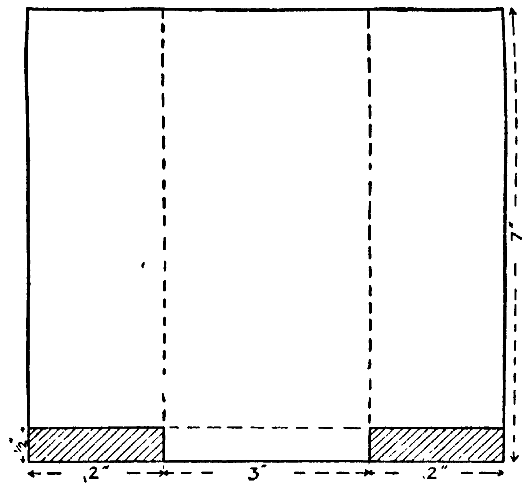
Measure the edges of the paper given to you.
What figure is it? What is the sum of all the edges?
Find the sum of 2 in. and $1\frac{1}{2}$ in.
Find the sum of $1\frac{1}{2}$ in. and $1\frac{1}{2}$ in.

$$1\tfrac{1}{2} \text{ in.} \times 2 = x \text{ in.};$$
$$3\tfrac{1}{2} \text{ in.} + 1\tfrac{1}{2} \text{ in.} = x \text{ in.};$$
$$5 \text{ in.} - x \text{ in.} = 3\tfrac{1}{2} \text{ in.}$$

Find the area of each of the rectangles, which are cut away.
Place them together so as to form another rectangle.
How long is the finished bag? how wide? Find area.

APPLICATION.

Let children use your crayons and make a mass drawing of the bag.



5. Square Envelope

CONSTRUCTION.

Cut away the waste.
Fold to opposite corners.
Gum one of the remaining flaps.
Brush the gum over the other flap and leave to dry.

EXERCISES.

What is the length of one side of the square? Find the perimeter.
What is the length of the side of the shaded triangle?
Find a half of 5 in.

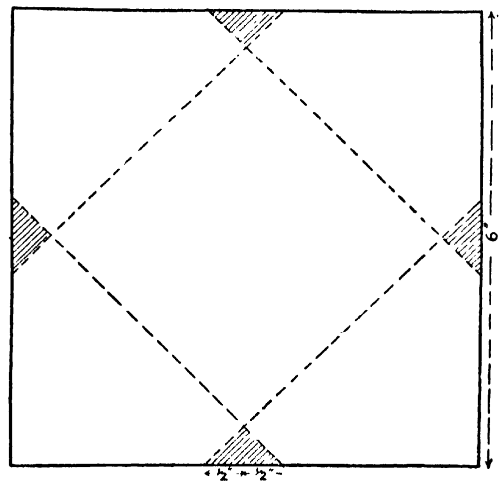
$$2\tfrac{1}{2} \text{ in.} \times 2 = x \text{ in.};$$
$$5 \text{ in.} \div 2 = x \text{ in.};$$
$$2\tfrac{1}{2} \text{ in.} + 2\tfrac{1}{2} = x \text{ in.}$$

What figures can be formed when the parts which are cut out are placed together?
Find the area of the remaining portion.
How much shorter is one edge of the envelope than the edge of the square from which it is made?
What is the total length of the four edges of the envelope?

APPLICATION.

The children should measure envelopes of various sizes, and construct an envelope after measuring the specimen given by the teacher.

Fold a piece of paper of suitable size and place it in the envelope.
Seal and address the envelope to your father or mother.



6. Trough

CONSTRUCTION.

Fold the square along its diameter, and then along the other lines in the opposite direction—like a fan. Bend the two inner flaps forward, and the outer flaps backward. The inner must be superimposed and gummed so as to form an oblique square.

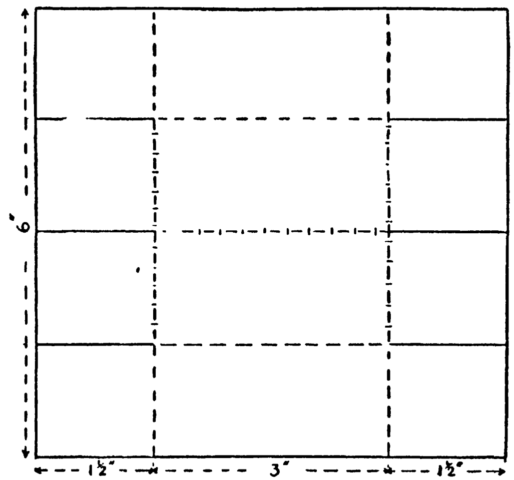
Fold the outside flaps to complete the trough.

EXERCISE.

Test the interior angle of the trough with the set-square to prove accuracy of construction.

APPLICATION.

If possible let the children measure an actual trough; make a rough sketch, and afterwards construct a model to a suitable scale.



7. Trough

(With Legs)

CONSTRUCTION.

Draw, fold, and cut as indicated in the diagram.

Note.—(1) That the middle line folds backwards, and (2) the diagonals of the end squares are made to fit in the inside of the corners of the rectangular sides.

EXERCISES.

Measure the length of the side of the trough.

$\frac{1}{2}$ of 6 in. = x in.

Measure the end.

$\frac{1}{2}$ of 3 in. = x in.

What is the perimeter of the top?

3 in. + $1\frac{1}{2}$ in. + 3 in. + $1\frac{1}{2}$ in. = x in.

Use your set-square to test if the angle folded inside is a right angle.

Examine the inside of the trough. How many sides are there?

How many are sloping sides? What shape are the sloping sides?

What shape are the other sides?

Find the difference in length between one long side and one short side; between two long sides and two short sides.

Find $\frac{1}{2}$ of 3 in.; $\frac{3}{4}$ of 6 in.

How many angles are there on each face? on all the faces?

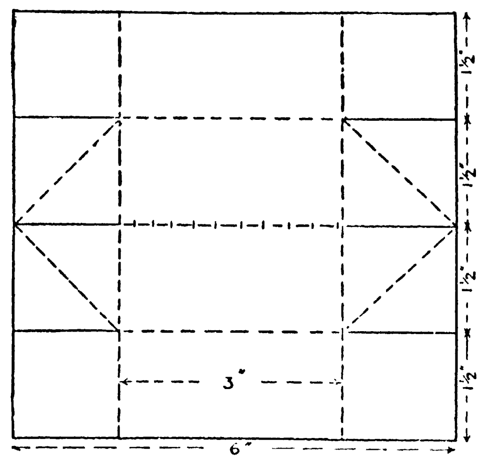
How many angles are there inside the trough?

Where are there angles greater than right angles in the trough?

Make a sketch of the model.

APPLICATION.

Suggest to the children that they should bring sketches of troughs which they may see in use, and ask why most of these have legs.



8. Barn

CONSTRUCTION.

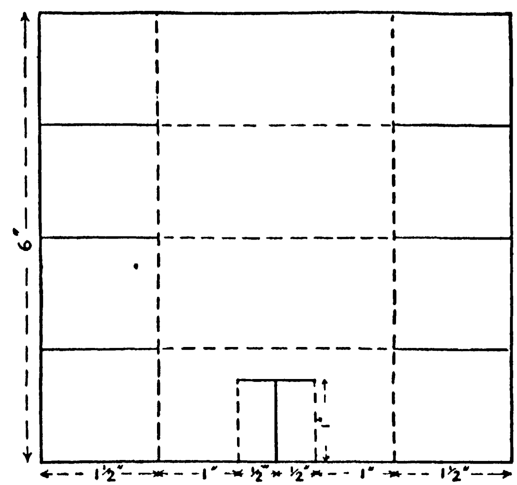
This presents no new feature to the last model, except that the top is formed by an outward fold and that an opening is required in the side.

EXERCISES.

How long is the barn? how wide?
Measure the oblique lines of the roof.
Test the top angle at each end.
What is the area of the two sloping roofs together?
Measure the opening for the doors.

$\frac{1}{2}$ in. × 2 x in.;
$1\frac{1}{2}$ in. × 2 = x in.

Find $\frac{1}{4}$ of 6; $\frac{3}{4}$ of 6.
What length of string would be required to reach quite round the barn at both ends?



9. Wall Pocket

(Straight Edges)

CONSTRUCTION.

Proceed as indicated in the diagram. Remove waste, and note that the flange A should be gummed on both sides and fixed between B and C.

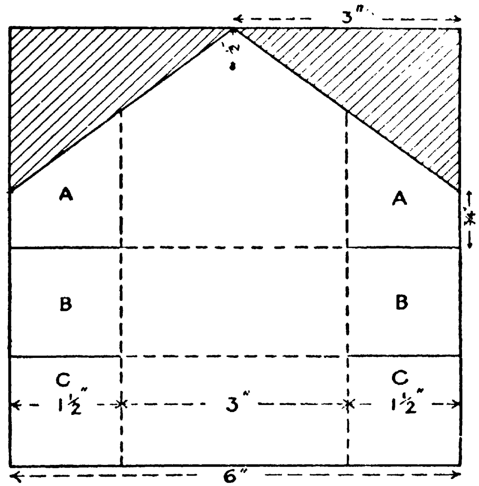
EXERCISES.

What shape are the parts which are cut off?
Measure the length of the shortest side of the triangle.
How much less than 3 in.? than 6 in.?
Measure the line opposite the right angle.
Place the two triangles together with their longest sides touching. Compare the lengths of these sides.
What figure have you formed? What kind of angles has the figure? Find its perimeter.
Place the completed model resting on one end.
Test if the end is a square. What is its area?
Turn the model round and find how many triangles there are.
Find the area of the rectangular front; of the base.
Make a drawing of the completed model.

APPLICATION.

1. Make a wall pocket without the corner struts; i.e. instead of cutting ¾ in. above the base of A, cut from the centre of the top line to the centre of the side. Note the advantage of having a strut, and call attention to its use in giving strength and rigidity to palings, posts, &c.

2. Let children make a model to scale of an ordinary soap-box of similar shape to the above. The measurements should be carried out by selected pupils themselves.

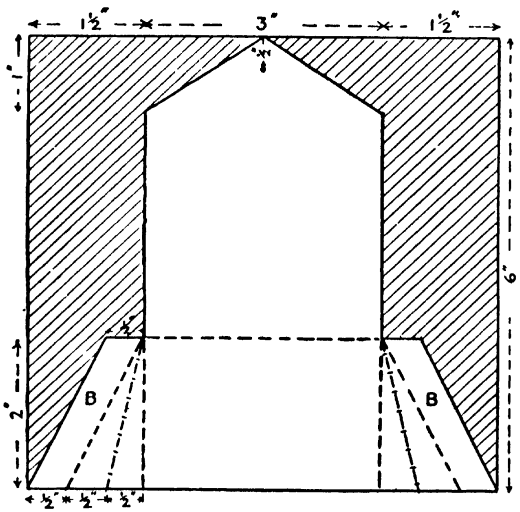


10. Wall Pocket

(Folding Sides)

CONSTRUCTION.

Draw, fold, and cut as indicated in the diagram.



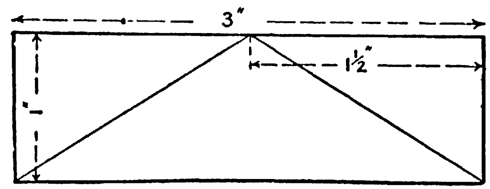
The flange B on each side is to be folded and fastened behind the model.

A punch will be required for the eyelet.

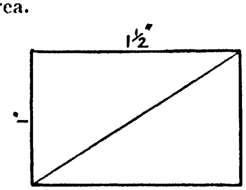
EXERCISES.

How wide is the front of the model? how high?
Find the area.

How high is the model from the fold to the apex?
How many oblique lines are there in the model?
Test the angle at the apex to see if it is greater than a right angle.
Which other angles are greater than right angles?
Examine the waste paper; how wide is it at its broadest part?
What is ½ of 6 in.? ¼ of 6 in.? ¾ of 6 in.?
How often is 1½ in. contained in 3 in.? 4½ in.? 6 in.?
How often is 1½ in. contained in ¾ of 6 in.?
How many half-inches in 1½ in?
What are six half-inches equal to?
How much is this less than 6 in.?
Cut out two triangles from the waste at the top.



Place their longest sides together. What figure is formed?
Find its area.



11. Triangular Trough

CONSTRUCTION.

Proceed as indicated in the drawing.

Note that the triangle A fits on B, and that the three central folds are placed inwards.

EXERCISES.

(Before cutting, &c.)

What is the perimeter of the outside square? of the inner square?

Find areas of both squares.

What part is the inner square of the outer square?

Measure the diagonals of the inner square.

Test the angles at the centre as before.

What part is A of the inner square?

What is the area of the inner square? of A and B together? of A?

Examine the completed model.

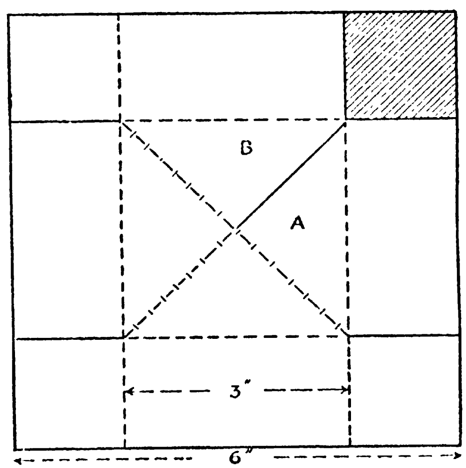
What is the shape of each side? How many sides are there?

How many triangles form the sides of the trough itself?

How many equal sides has each of these triangles?

APPLICATION.

A lesson should follow here on the Equilateral Triangle; Isosceles Triangle.



12. Stool

CONSTRUCTION.

This model requires careful measurement.

The legs should be fastened to the sides 1" from either end.

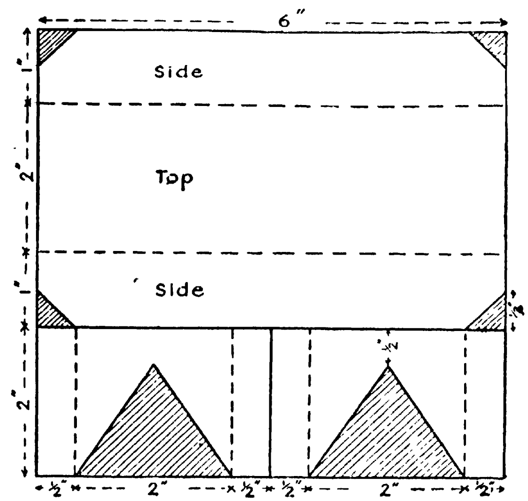
EXERCISES.

How long is the stool? how wide?

How far is it round the top?

How wide is each leg?

How many half-inches are there in the difference between 4 in. and 6 in.?



13. Garden Seat

CONSTRUCTION.

This model should now present little difficulty.

The curve to the back of the seat is obtained by rolling the paper on a pencil.

The legs are fastened 1 in. from each end as in the last exercise.

EXERCISES.

If the seat were 6 ft. long, how many boys could sit on it allowing each 1½ ft. room?

Add together 2 in., 1½ in., ¼ in. How much less than 4 in.?

Add together two ½ in., four ¼ in., and 1½ in. How much less than 6 in.?

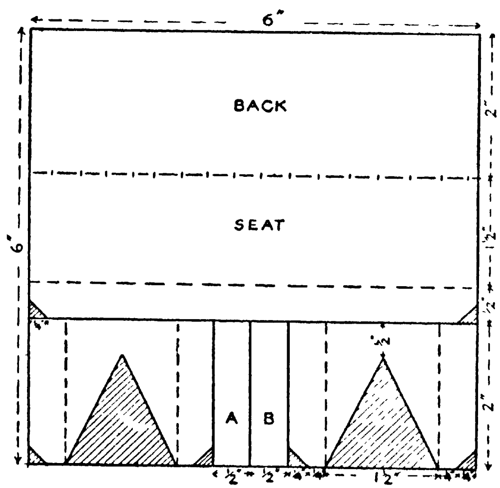
How far would 3, 4, 5, 6 seats reach if placed end to end? (Answer in feet.)

How far would 4, 5, 6 seats reach if each measured 6 ft.? (Answer in yards and feet.)

How many children could occupy a block of six 6-ft. desks allowing each 1½ ft.?

APPLICATION.

Exercises should follow in measurement of the school desks, blackboards, doors, walls, playground, &c.



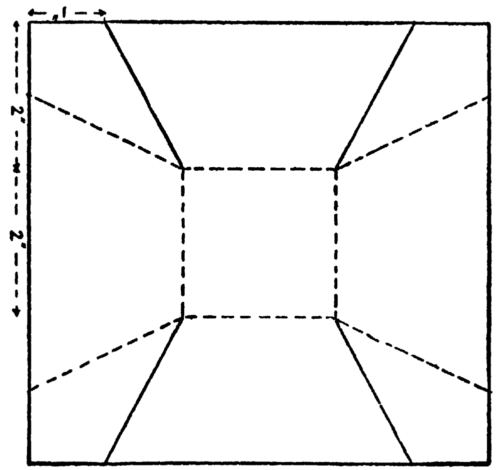
14. Washing Tub

CONSTRUCTION.

Draw, cut, and fold as shown in the diagram. The flanges are to be placed two on each end.

EXERCISES.

How long is the top of each side of the finished model?
What is the distance round the top? the bottom?
¼ of 16, ¾ of 16, ¾ of 8.
What is the area of the top? of the bottom?
How often would 16 sq. in. contain 4 sq. in.?
How many sloping sides are there?
Measure the long sloping sides.
If the area of the base is called "one", what would the area of the top be called?



15. Photograph Frame

CONSTRUCTION.

A base of thin card 6 in. square is required for this model.

A piece of paper is then cut as shown in the diagram.

Each of the portions should be rolled back to the centre of the side of the paper square, and fastened by means of a paper fastener.

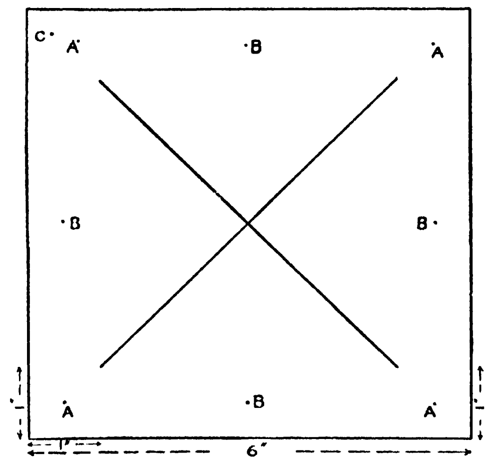
The whole should then be fastened as indicated at A to the thin card.

The fasteners at B do not go through the card, so as to allow of the picture or photograph being placed in the frame.

Make an eyelet at C and hang by using ribbon.

EXERCISES.

Question on angles, oblique lines, &c.



16. Luggage Label

CONSTRUCTION.

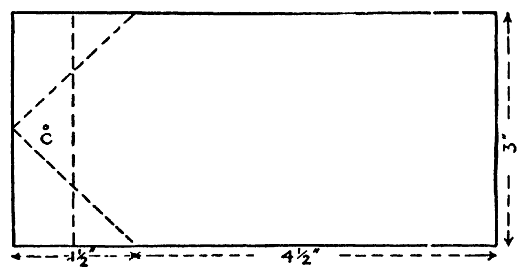
Draw an oblong 6″ × 3″ and fold as indicated.
Make a hole at C and insert and fasten the string.

EXERCISES.

Measure the length of the oblong portion of the label.
How wide is it?
4½ in. × 2 = x in.
Count the edges of the label.
Measure the length of each.
Find the perimeter.
How many angles are there? how many right angles?

APPLICATION.

Pupils may direct the label to mother, giving full name and correct postal address.



17. Oblong Box

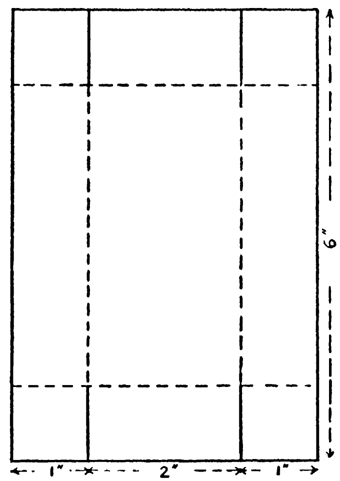
(Rectangular Sides)

CONSTRUCTION.

Draw, fold, and cut as indicated.
Fasten the flanges on the outside.

EXERCISES.

Count the faces of the model.
How many edges are there? how many long edges? how many short edges?
Measure the longest edge; the shortest edge; the width.
Find the area of the bottom; the side; the end.
Find the distance round the top; the side; the end.



18. Oblong Tray

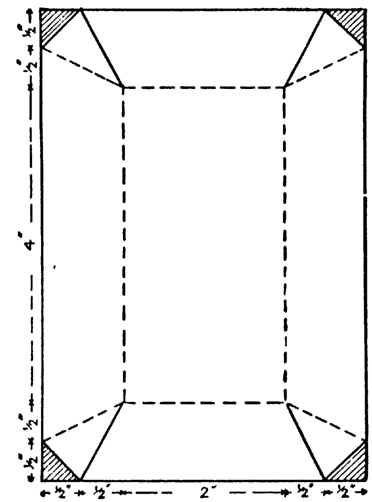
(Sloping Sides)

CONSTRUCTION.

Draw, fold, and cut as indicated.
Paste the flanges at the back.

EXERCISES.

How many oblongs or rectangles are there in the finished model?
What kind of angle is each angle at the bottom sides of the tray?
Test the angles at the top.
How much is a long side at the top greater than a long side at the bottom?
How much is a short side at the top greater than a short side at the bottom?
Find the perimeter of the top side; of the bottom side.
Make a hand sketch of the tray, and mark its dimensions.



19. Comb Case

CONSTRUCTION.

Draw, fold, and cut as indicated.

The method of obtaining the angular cut will need considerable care.

EXERCISES.

Make a drawing of the comb case and insert each measurement.

How many right angles are there? how many acute angles?

Explain where the obtuse angles are situated.

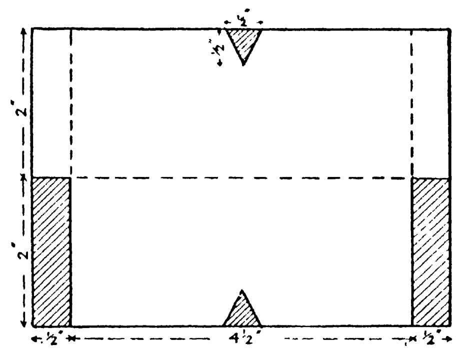
Find the perimeter of the finished model.

What is $\frac{1}{2}$ of $3\frac{1}{2}$ in.? $1\frac{3}{4}$ in. + $1\frac{3}{4}$ in. = x in.

What is the distance from the apex of the angle cut out to the centre of the bottom line?

APPLICATION.

The children should measure a comb at home and make a case for it.



20. Punt

CONSTRUCTION.

Make a rectangle as indicated.

Use your ruler and find the total length of a line which is made up of ¾", 2", ¾", ½", ½".

The three seats and the pole are cut out, and the pole is rolled with the fingers. After the body of the punt is completed the seats are folded and then pasted in position; the two end ones to touch the fold for the sloping ends of the punt and the other in the middle.

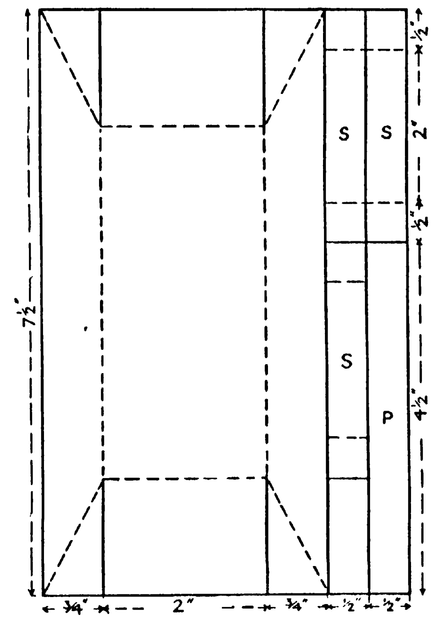
EXERCISES.

Let the children measure the longest lines in the model. How long would they be if placed together?

Find the perimeter of the bottom rectangle.

Examine the long sides. How many angles are there in a side? how many obtuse angles? how many are acute?

Make a drawing of the punt.



21. Notice Board

CONSTRUCTION.

In the triangular post the sides marked 1, 2, and 3 are folded as shown, and side 4 is pasted to side 1.

The struts are obtained by cutting an isosceles right-angled triangle, the equal sides being 2 in.

The bottom flanges of the post should be folded at right angles to the sides and pasted in the centre of the base.

EXERCISES.

What is the width of the rectangle used to form the post?

What is its length? How high is the post?

Make a rectangle 2 in. by ½ in. Cut and arrange so as to find area in square inches?

(1) ½ in. × 2 in. = x sq. in.

What is the area of the rectangle used to form the post itself?

(2) 7 in. × 2 in. = 14 sq. in.

Combine (1) and (2): 7½ in. × 2 in. = 15 sq. in.

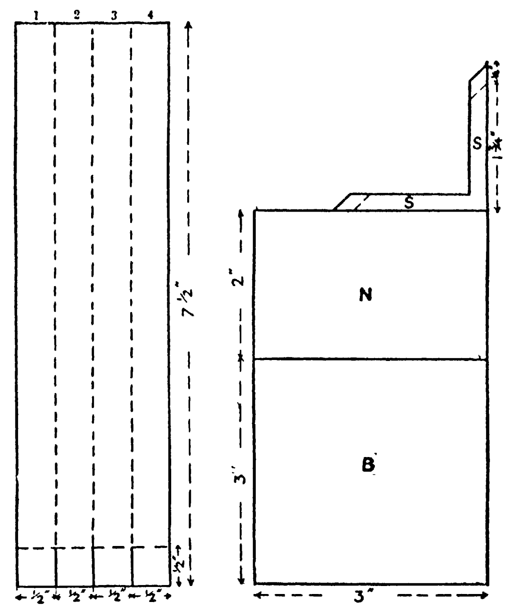
APPLICATION.

Ask why a strut is necessary? Test by making a model without struts.

Ask where children have noticed struts in use.

Print a suitable notice on the model.

Make a drawing of the model.



22. Screen

CONSTRUCTION.

Draw, fold, and cut as indicated.

The top of each panel may be decorated with crayon or brush.

EXERCISES.

Try to form a rectangle with the parts cut out as waste.

Find its length; breadth.

If it were 1 in. high, what would its area be?

If it were $\frac{1}{2}$ in. high, what would its area be?

What is the area?

$$\tfrac{3}{4} \text{ of } 3 = x; \ \tfrac{3}{4} \text{ of } 9 = x.$$

Measure the length of one of the oblique lines of the panel.

What would be the total length of the eight oblique lines?

How much binding for the edges would be required if the bottom is unbound?

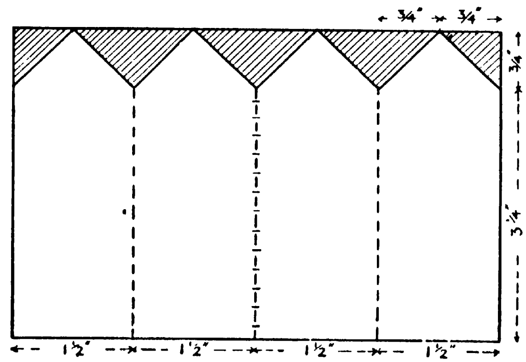
What length of binding would be required if the three folded lines are covered as well as the edges as above?

APPLICATION.

Suggest that the pupils should measure various-shaped screens and bring dimensioned drawings for use in constructing models.

Why are screens generally made to fold?

Let children make a memory drawing of a screen and colour with crayons.



23. Fire Shovel

CONSTRUCTION.

Draw, cut out, and fold as indicated.

EXERCISES.

Take the two large pieces of waste and place the short sides end to end. What have you formed?

How long is your rectangle? 2½ in. × 2 = x in.

Now place the long sides together.

Measure the distance round each side.

Find the perimeter. 2½ in. × 4 = x in.

Test the angles with your set-square.

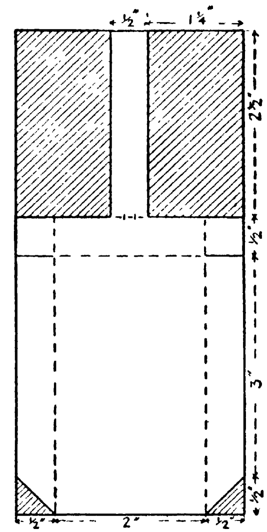
Try if a square can be formed with the two small pieces of waste.

How often would this small square be contained in the larger one?

APPLICATION.

Discuss reason for sloping edge of the front of the two sides of the shovel. Why not square?

Ask for other examples.



24. Sledge

CONSTRUCTION.

Draw, fold, and cut as indicated.

The right-angled triangles B are cut out and pasted so as to fasten the parts marked A to the sides of the sledge.

EXERCISES.

Measure the length of the seat of the sledge. How high is the back above the seat?

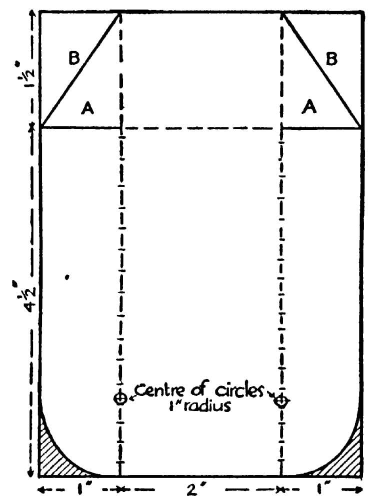
Take a piece of cotton and use it to measure on your ruler the total length of the base line of the model and the curve to the seat.

If every inch in the model represents a foot in your sledge, what length would an iron runner be if it completely covered the part you have measured, and curved round 1 ft. from the back.

APPLICATION.

Let children sketch the model.

Question as to its uses, &c.



Educational Handwork

Intermediate Course

J. L. MARTIN
AND
C. V. MANLEY

INTRODUCTION

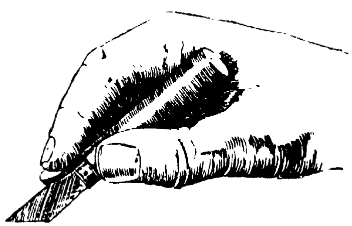
Materials required for Intermediate Course

Materials:—

Stout cartridge paper, carton paper, and thick cardboard (four sheet).

Knife:—

"London" pattern, with finger rest as illustrated. This may be procured from the Lloyd Tool Company, Sheffield.



Adhesive:—

Duckett's Pastem, 6*d.* per packet; Le Page's liquid glue, 2*s.* per pint; Higgins's photo mounter, 4*s.* 6*d.* per dozen.

Ruler:—

Safety Ruler (Charlecote), 6*d.*; Charles & Dible.

Millboards:—

Cutting boards, 6*s.* per gross.

Scissors:—

5*s.* 6*d.* per dozen.

Stencil Brushes:—

Reeves's, 2*s.* 6*d.* per dozen.

The Use of the Knife

Special attention is necessary to the correct method both of holding and using the knife. It should be grasped firmly with the forefinger on the rest. (See above.)

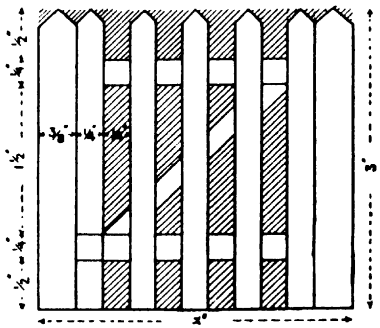
Several light cuts are preferable to one heavy cut. The ruler should always be placed on the drawing, so that a slip could only damage the waste part to be cut off. Care should be taken to cut the line through its entire length before removing, so as to leave a clean edge.

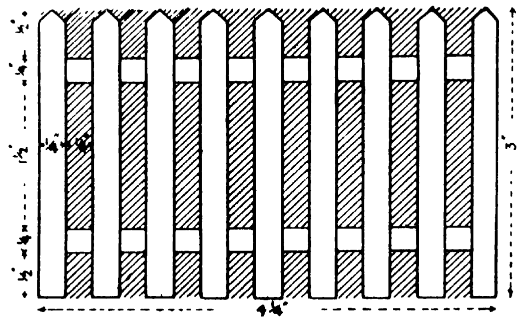
Suggested Exercises:—

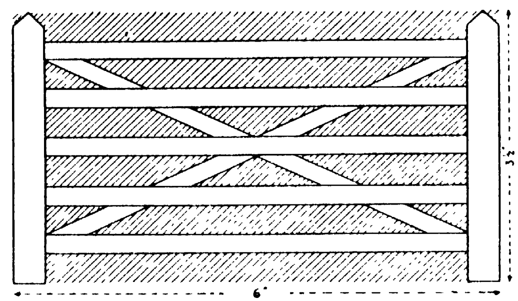
1. *Wooden palings.*—Measure a suitable fence in the neighbourhood of the school, and reduce it to the scale of 1″ to 1′. Cut out as indicated in the sketch.

2. Make a dimensioned sketch of a five-barred gate, and afterwards draw to scale and cut out.

3. Similarly make a scale drawing of a school window, and cut out so as to show the frame.







THE CUBE AND RECTANGULAR PRISM

Examination of an Inch Cube

Materials required: Each child should be provided with 27 in. cubes, set-squares, and inch rulers.

The children examine the cube, and make written and oral statements from their own observations.

Faces: (1) The cube has six faces.
(2) Each face is a square.

Angles: The cube has 24 right angles.

Edges: The cube has 12 equal edges.

Practice has already been given in using the *inch* as a unit of length and the *square inch* as the unit of area. The object of this exercise is to give notions of solidity, and to explain the use of the *cubic inch* as the unit for measuring volume.

Exercises in Building Solids of various Dimensions

Ex. 1.—Without any previous instruction except such as is given above, require the pupils to construct (*a*) a two-inch cube, (*b*) a three-inch cube.

Criticize and discuss their efforts. Special emphasis should be laid on the fact that the area covered by the base of the solid is equal to the number of cubic inches in the bottom layer, i.e. each cubic inch covers an area of 1 sq. inch.

Ex. 2.—Using the same number of inch cubes as in (*a*) and (*b*) above, construct other rectangular solids, and write down their dimensions.

Ex. 3.—Measure various cubical and rectangular solids, i.e. boxes, &c., and find their volume in cubic inches.

Ex. 4.—Measure larger rectangular solids. Using the kindergarten cubes, construct these to a scale of 1″ to 1′, and find their volumes.

Ex. 5.—(*a*) Find the distance round *one* face of the cube if the edge is 1″, 2″, 3″, 4″, &c.

(*b*) Find the length of *all* the edges if each measures 1″, 2″, 3″, 4″, &c.

Ex. 6.—As an introduction to mathematical generalization, a cube which the pupils had not previously examined should be placed before them; and oral exercises should be given as follows:—

(*a*) If we call one edge x'', what would be the length of 2, 3, 4, &c., edges?

(*b*) If each edge be increased by 1″, what will be the length of 2, 3, 4, &c., edges?

(*c*) If each edge be diminished by 1″, what will be the length of 2, 3, 4, &c., edges?

$$(x - 1) \text{ in.} \times 2 = (2x - 2) \text{ in.}$$
$$(x - 2) \text{ in.} \times 2 = (2x - 4) \text{ in., \&c.}$$

(*d*) If we call each edge $2x''$, what would be the length of 2, 3, 4, &c., edges?

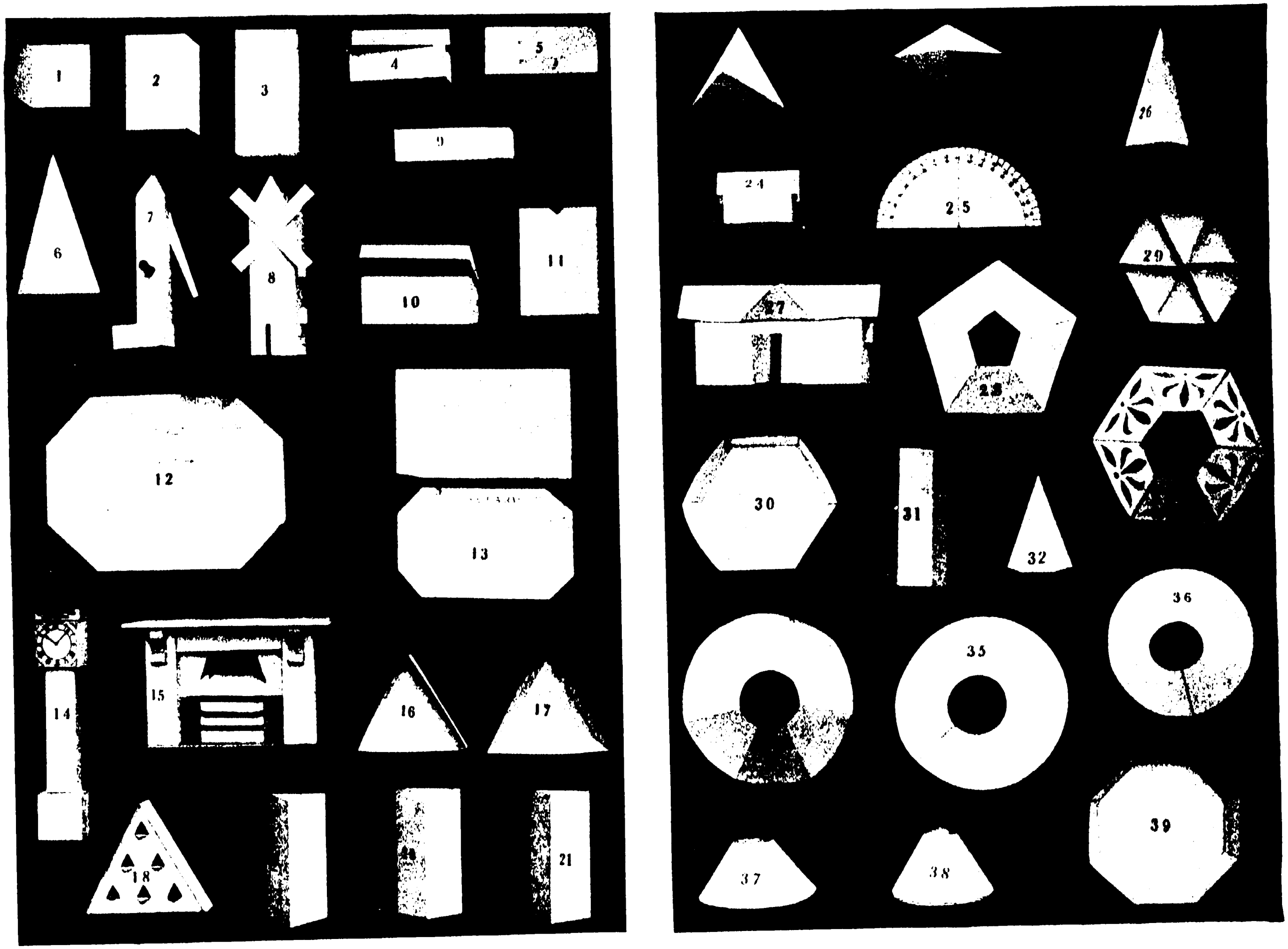
(*e*) If each edge be increased by $1''$, what will be the length of 2, 3, 4, &c., edges?

$$(2x - 1) \text{ in.} \times 2 = (4x - 2) \text{ in.}$$
$$(2x - 1) \text{ in.} \times 3 = (6x - 3) \text{ in., \&c.}$$

It should be recalled that the area of a 2-in. square $= (2 \times 2)$ square inches, and that of a 3-in. square $= (3 \times 3)$ square inches, and it should be pointed out that for convenience we write 2^2, 3^2, 4^2, x^2. Oral and written exercises should follow on the squares of numbers.

The teacher will be guided entirely by the capacity of the class as to how far he will make use of the various exercises. (Some may be deferred.)

MODELS FOR INTERMEDIATE COURSE



1, The Cube. 2, Square Prism. 3, Oblong Prism. 4, Box with Lift-off Lid. 5, Money-Box. 6, Square Pyramid. 7, Pump. 8, Windmill. 9, Sliding Match-Box. 10, Box with Hinged Lid. 11, Card Case. 12, Blotting Pad. 13, Postcard Holder. 14, Grandfather's Clock. 15, Fire-place. 16, Triangular Tray. 17, Equilateral Triangular Tray. 18, Dovecot. 19, Triangular Prism. 20, Right-angled Triangular Prism. 21, Scalene-Triangular Prism. 22, The Tetrahedron. 23, The Hexahedron. 24, Dog-Kennel. 25, Protractor. 26, Triangular Pyramid. 27, The Barn. 28, Pentagonal Lampshade. 29, Hexagonal Tray (Rectangular Sides). 30, Hexagonal Tray (Sloping Sides and Curved Edges). 31, Hexagonal Prism. 32, Hexagonal Pyramid. 33, Hexagonal Lampshade. 34, Heptagonal Lampshade. 35-38, Candle Shades. 39, Octagonal Tray.

1. The Cube

CONSTRUCTION.

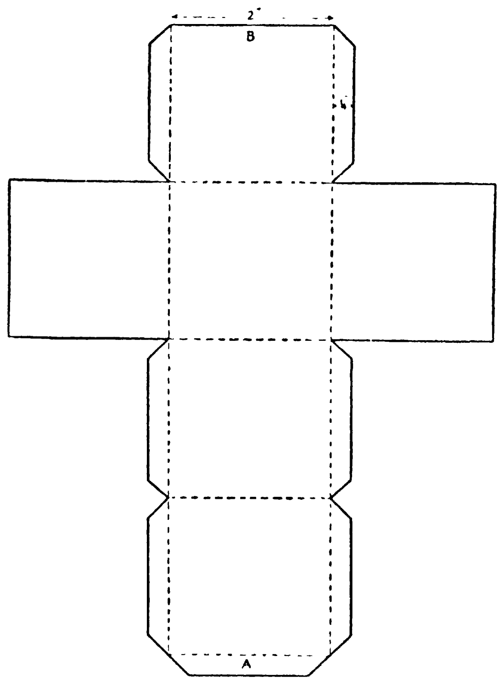
Each child should roll a completed specimen on paper, marking the plan at each stage.

The development should then be drawn. Folds should be made along all the dotted lines. The flap A should be fixed to flap B first. This should be done by folding across the middle line. This allows of the first join being made in the flat position. The ends are then fixed, all flaps being inside.

EXERCISES.

1. Combine models to make larger cubes, and calculate their volumes.
2. Let children measure the dimensions of certain cubical solids and vessels, and calculate their volumes and capacities.
3. (*a*) For large objects, show the necessity for a larger unit than the "cubic inch", i.e. the "cubic foot". A cardboard model of a "cubic foot" should be exhibited, and its volume in cubic inches found. Note that it is composed of twelve layers of 144 cub. in. = (12 × 12 × 12) cub. in.

   (*b*) $2^3 =$; $3^3 =$; $4^3 =$
4. A drawing of the completed model should now be made.
5. Find the surface area of the cube.
6. How many cubic inches would the model hold? Compare a 2-in. cube and 2 cub. in., a 3-in. cube and 3 cub. in., a 2-in. cube and a 3-in. cube.



7. Complete the following:—

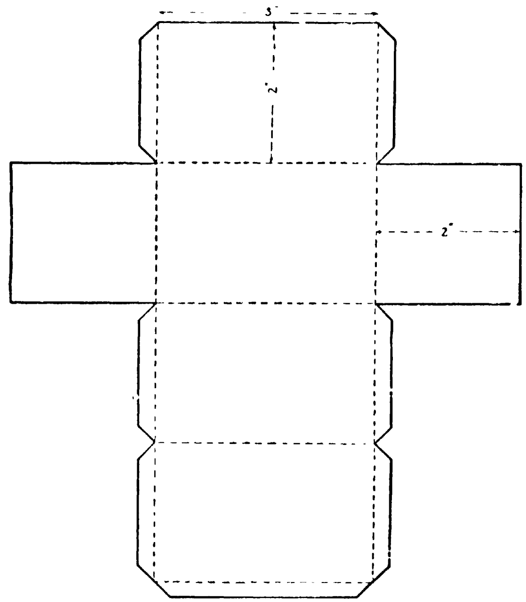
Edge of cube	1	2	3	4	5	6	7	8	9	10	x	2x	Units
Area of one face . .													Square units
Volume of cube ...													Cubic units

8. Count the number of horizontal and vertical lines there are when a cube is lying on one of its faces.
9. Tilt the cube on one of its edges. Let its face rest on the edge of a set-square. (*a*) How many oblique lines are there? (*b*) Are there any horizontal lines?
10. If a long hatpin were pushed through the cube diagonally, and it were run vertically through into a desk, how many edges would be oblique? How many faces would be oblique?

2. Square Prism

EXAMINATION AND COMPARISON.

A few completed specimens of square prisms, 2″ × 2″ × 3″, should be passed round the class for examination. The pupils will readily note that the base of the cube in the last model and that of the square prism are equal, but that the heights are unequal. They should then be required to make a sketch of the model and insert the dimensions.



CONSTRUCTION.

Proceed exactly as in the last exercise. Place the rectangular side on paper and revolve, marking the plan at each stage as before.

Such questions as the following should then be asked:—

1. How many faces are there? edges?

2. What is the area of each long face? of each short face? of the whole prism?
3. What is the greatest number of faces, edges, and corners which can be seen at any one time?

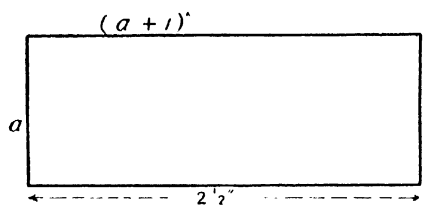
EXERCISES.

1. Square prisms should be built with inch cubes, and the rule for volume developed.

   Volume = Base Area × Height.

2. Calculate volume, using the oblong side as base.
3. Find the volume of a square prism having a base of 3″ and a height of 5″.
4. A cistern has a square base of 2 ft. side and a height of 3½ ft. Draw the development (scale 1″ to 1′), and find the area of a long side, and the capacity of the cistern.
5. Find the perimeter of the rectangular sides of a square prism if the short side is a in. and the long side is 1″ longer.

   Find the length of all the edges of the prism.

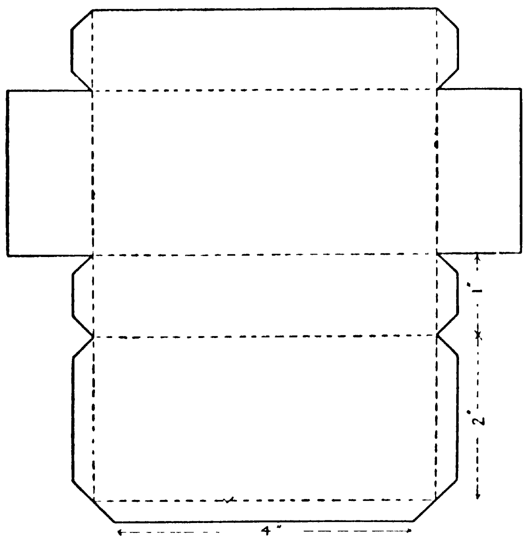


6. Find the perimeter of the rectangular sides of a square prism if the short sides are x in. and the long sides y in.
7. Find the perimeter of all the edges of the prism in the last exercise if the edges are all increased by a in.
8. Find the perimeter if the short edges are increased by a in. and the long edges diminished by a in. What would be the length of two short edges and two long edges?
9. Draw the plan of a square prism having a base of 2½ in.
10. Draw the elevation of a square prism having the sides of its square base 2½ in. and its height 4 in. Find its volume.

3. Oblong Prism

EXAMINATION AND COMPARISON.

A few completed specimens should be distributed for examination. The edges should first be measured, and the pupils will readily notice that there are three dimensions, differing in length.



A sketch showing dimensions should then be made.

CONSTRUCTION.

Proceed exactly as in last exercise.

The principles, as to volume, established in the previous exercises will render it unnecessary to construct oblong prisms using inch cubes.

EXERCISES.

1. Find the area of the smallest sides; of the largest sides; of the two other sides.
2. Write, in your notebook, statements as to the differences and resemblances between the cube, square prism, and oblong prism.
3. Find the volume of various oblong prisms, e.g. boxes, drawers, &c.
4. Calculate the volume of a brick to nearest inch (9" × 4½" × 3").
5. What is the perimeter of all the edges of a brick?
6. If the shortest edge of a brick measure a in., what would the longest measure? Find the perimeter, calling the shortest edge a inches.
7. Make a drawing showing the plan and two elevations of a brick to scale (half-size).
8. If the base of an oblong prism containing 81 cub. in. has an area of 9 sq. in., what is the height?
9. If the three dimensions of an oblong prism are x, $x + 2$, and $x + 3$ inches, find the perimeter.
10. If the base of a square prism has an edge of x in., and the long edges are each y in.:

    (a) How would you express the total length of the short edges? of the long edges? of all the edges?

(*b*) What is the area of the base in square inches? What is the area of the two square ends?

(*c*) Make a sketch of the long face, marking one edge x in. and the other y in. What is the area of one long face? of all the long faces?

(*d*) What is the area of all the faces?

(*e*) Multiply the area of the base by the altitude, and so find the volume.

---

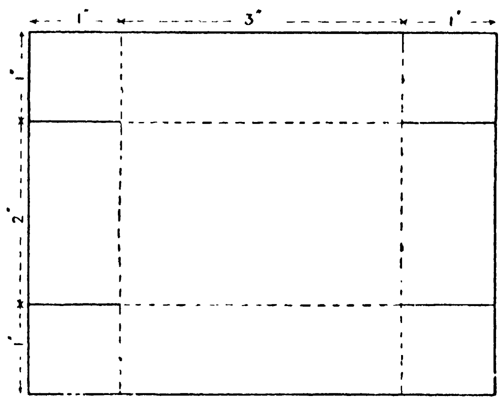
4. Box with Lift-off Lid

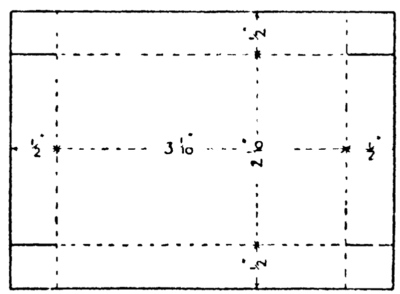
CONSTRUCTION.

Completed models should be distributed, and the children should be required to measure the dimensions of each edge of the box and then of the lid. They will note the allowance of $\frac{1}{10}''$ in the top of the lid. The teacher should question as to the amount of paper required for the two parts of the model.

EXERCISES.

1. Discuss the theory of fitting lids to boxes. Note that the inside measurement of the lid should equal the outside measurement of the box together with a small allowance for fitting.
2. Discuss the advantages of lids: a protection of contents, &c.
3. Examine each side of the box. Find its area.
4. How many square inches of paper could be pasted round the four sides of the box?
5. How many inch cubes would fill the box?
6. How many inch cubes would a box $5'' \times 2'' \times 1''$ hold? How many would it hold if its height were increased $1''$? $2''$?





THE LID

The development of the lid should again be drawn, and the dimensions filled in. The attention of the pupils should be called to the other method of writing $3\frac{1}{10}''$ (3·1), and with the help of the scale ruler divided in tenths it may readily be elicited that $\frac{1}{2}'' = \frac{5}{10}''$ and may be written ·5″.

Simple exercises would follow on the addition, subtraction, and multiplication of decimals to one place.

The pupils will readily see that 3·1 may also be read as 31 tenths, &c.

If thought advisable, this lesson should be followed by simple lessons on the metric system. The children should examine their rulers and note the centimetre; that each centimetre is divided into ten parts each called a millimetre. The completed model should then be measured in centimetres and parts of a centimetre, thus: Box—

Long edge,	7·6 cm.	7 cm. 6 mm.	76 mm.
Short edge,	2·5 cm.	2 cm. 5 mm.	25 mm.
Other edge,	5·1 cm.	5 cm. 1 mm.	51 mm.

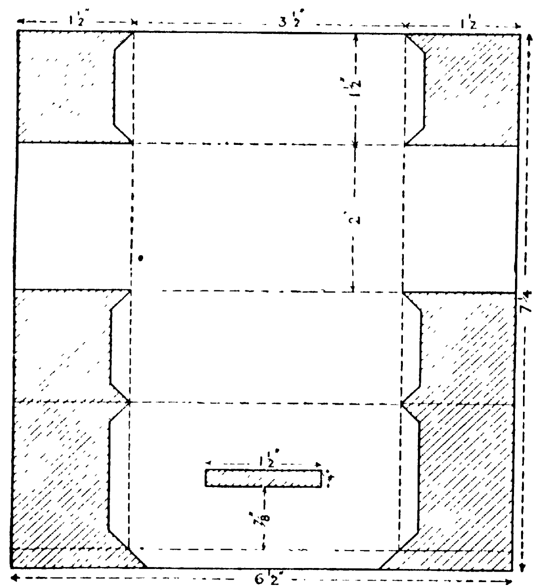
EXERCISES.

1. Find the perimeter of the largest oblong in centimetres and parts of a centimetre. Find the perimeter of each of the other oblongs.
2. Draw lines $4\frac{1}{2}''$, $3\frac{3}{4}''$, $5\frac{1}{2}''$, 6″, and find their length in centimetres and millimetres.
3. Draw lines 5·3 cm., 4·6 cm., 7·8 cm., 10 cm. in length.
4. Make a box having sides of 10 cm., 5·5 cm., and 2·5 cm.

5. The Money Box

CONSTRUCTION.

The pupils will readily observe that the model is an "Oblong Prism". The method of procedure is



precisely similar to that employed in that exercise. Care must be taken in marking the position and in cutting the slot. The whole of the development

should be drawn without any assistance from the teacher. In order that the slot may be correctly placed, such exercises as the following may be given before the slot is marked: -

1. How long is the model? How much longer is it than the slot? What distance must be left on each side so that the slot may be exactly in the centre?

   Draw dotted lines 1" from each side in the bottom rectangle of the development.

2. How wide is the bottom rectangle? the slot? How many 8ths of an inch in 2"? How many 8ths in ¼"? What is the half of fourteen 8ths?

   Carefully measure ⅞ths down each side in the bottom rectangle. The bottom line of the slot may be obtained by measuring from the lower edge of the model.

EXERCISES.

1. What is the perimeter of the base of the model?
2. Measure a long edge. If the long edge is x in., what is the perimeter of one end? of two ends? of the middle-sized rectangle?
3. What is the area of the bottom? of the ends?
4. How high is the money box? If the height were 3", what would be the area of one side?

   (3½" × 3") = 10½ sq. in.
   (3½" × 1½") = sq. in.

5. Find the area of the slot.

   1½" × 1" = 1½ sq. in.
   1½" × ½" = sq. in.
   1½" × ¼" = sq. in.

   Find the area of the remaining portion of the top.

6. Find the volume of the oblong prism.
7. An oblong prism is 10 cm. high, 12·5 cm. long, and 7·6 cm. wide: (*a*) Find the area of each of its four largest sides; (*b*) find the perimeter of all its edges;

   (*c*) (12·5 cm. × 10 cm.) = sq. cm.
   (7·6 cm. × 10 cm.) = sq. cm.

   Find the difference between these results.

   (*d*) (4·9 cm. × 10 cm.) = sq. cm.

   Compare the last two answers.

8. Measure the edges of the completed model of the money box in centimetres and parts of a centimetre. Complete –

	cm.			cm.
Long edge =		;	Two long edges =	.
Short edge =		;	Two short edges =	.
Other edge =		;	The two other edges =	.
Total =		;	Total =	.

9. How much longer are two long edges than two short edges?
10. How much longer are two long edges than the other edges?

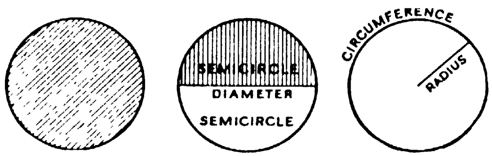
The Circle

(Each child should be provided with a kindergarten circle, say 6″ diameter.)

The children should be asked to compare the circle with the square. How many edges, corners, angles, &c., does it contain?

They should next fold the circle into two equal parts. (*Semicircle.*)

They should be asked to make statements about the edges of a semicircle. It is partly curved and partly straight.



Let them measure the length of the diameter.

The circle should then be opened, and folded again into two equal parts along a new diameter. Measure the diameter again. Repeat this several times.

Call the attention of the class to the point through which all the diameters pass. (*The centre.*)

They should then be required to draw a line AB 3″ long, and then draw from A four other lines, in various directions, 3″ long.

Compasses should then be used to describe a circle having point A as the centre—the radius being 3″. Note the five lines drawn from the centre A to the outside of the circle.

Each of these lines is called a *Radius.*

The boundary line is called the *Circumference.*

There should be no confusion between what is meant by the terms *Circle* and *Circumference.*

Compare the radius of a circle and its diameter.

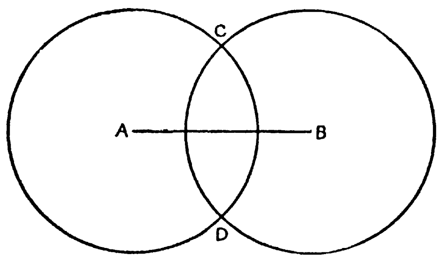
EXERCISES.

1. Draw and cut out circles having a radius of 2¼″, 1¾″, and 1½″.
2. Draw and cut out circles having a diameter of 5″, 4½″, and 2½″.
3. Draw a line AB 5″ long. Mark the centre C, and with a radius of 2½″ describe a circle.

   From point A draw five lines passing through the circle to touch the circumference.

   Compare the lengths of these lines with AB.
4. Fold a circle into four equal parts, called *quadrants*, and with the set-square test the angles at the centre.

Lines, Angles, and Triangles



1. Take any two points A and B 5 cm. apart. With centres A and B and radius 3·5 cm., describe two circles. What points are 3·5 cm. from both A and B?

2. *To bisect a line AB*—

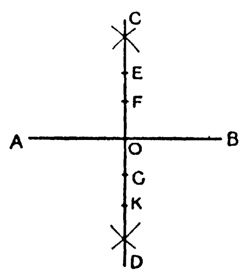
(*a*) Take a radius more than half the line, and describe two arcs with A and B as centres.

Let the arcs cut in points C and D.

Join C and D, cutting AB in point O.

Measure AO and BO.

The line AB has been bisected.



(*b*) Take any other points in CD, as E, F, G, K, and measure from A and B to each of them.

(*c*) Draw an arc AB, and bisect it in the same way.

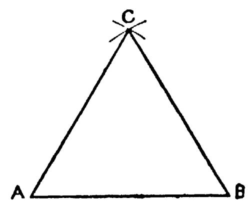
3. *To describe an Equilateral Triangle*—

Draw AB 4·5 cm. long.

With radius 4·5 cm. and centres A and B, describe two arcs intersecting at C.

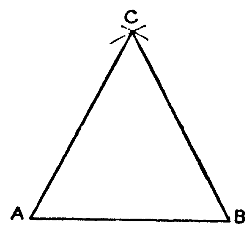
Join CA and CB.

ABC is an Equilateral Triangle.



4. *To describe an Isosceles Triangle*—

Draw AB 4·5 cm. long.



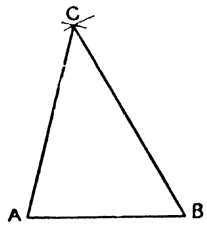
With radius 5 cm. and centres A and B, describe two arcs intersecting at C.

Join CA and CB.

ABC is an Isosceles Triangle.

5. *To describe a Scalene Triangle*, having sides 3·5 cm., 4·5 cm., and 5 cm.

Draw a base AB 3·5 cm.



With centre A and radius 4·5 cm., draw an arc; and with centre B and radius 5 cm., draw another arc intersecting the previous one at point C.

Join CA and CB.

6. The Square Pyramid

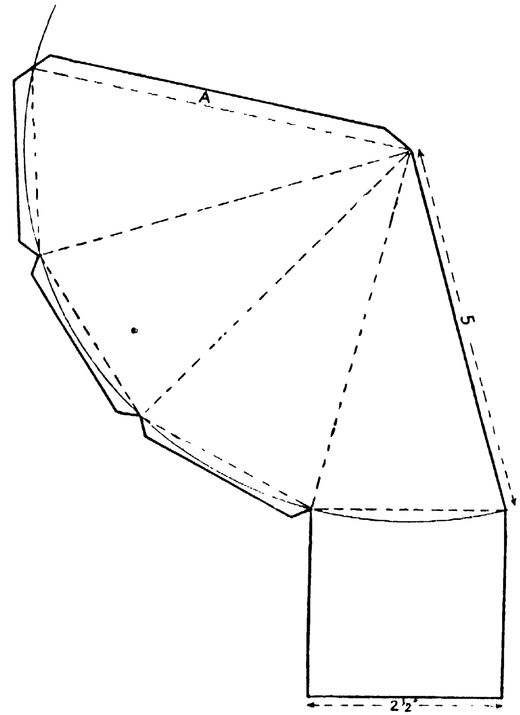
EXAMINATION AND CONSTRUCTION.

The children will discover for themselves that the model has a square base (2½″ side) and four isosceles triangles for its sides.

The method of constructing the development may be shown by cutting down one of the long edges and opening out the square base. As an alternative, place the base of the model on the paper, and, after marking round the edges with a pencil, tilt the model so that a triangular face touches the paper, and revolve until the four triangles have been marked.

The construction affords a valuable exercise for proving that the radii of a circle are equal.

Note that flap A should be pasted first.



EXERCISES.

1. Make a hand sketch of the pyramid, inserting the various dimensions.
2. (*a*) Construct four isosceles triangles having sides of 5", 5", and 2".

   (*b*) Cut out the triangles. Bisect one of them by drawing a line from the apex to the centre of the base. Cut along the line. Measure the length of this bisector.

   Arrange the triangles so as to form a rectangle. Find its area.
3. What is the total surface area of the pyramid if the short edge is a cm. and the height of one of the triangles is b cm.?

7. The Pump

CONSTRUCTION.

Draw the development. Cut and fold as indicated.

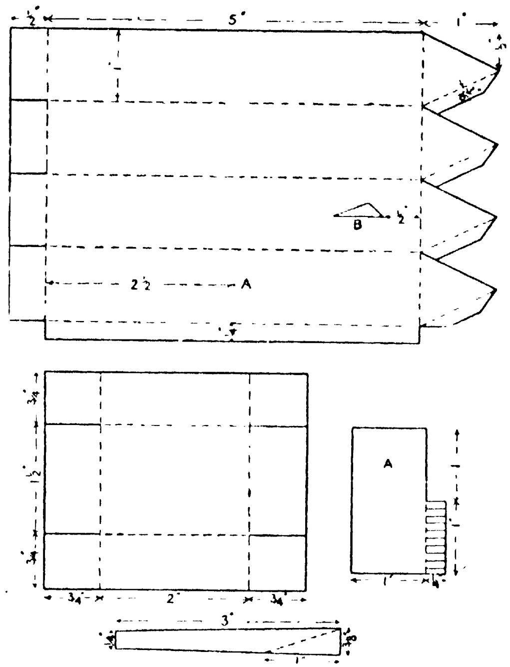
1. Body of Pump.—The side flap should be fixed first; then the bottom.

Paste the four flaps at the top. Place in position, and hold till fixed.

2. Spout.—Roll round a lead pencil. Unroll and paste portion A. Roll again, and hold till fixed.

The narrow flaps should be spread out to form a star. Fix to the body of the pump at A, $2\frac{1}{2}$" above the base.

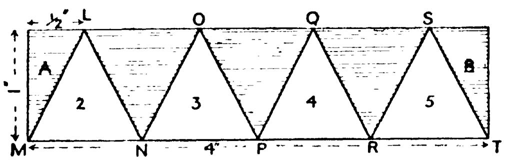
3. Fix the handle at B, $\frac{1}{2}$" from the top of the rectangle, and fasten the trough as indicated.



EXERCISES.

1. What is the area of the base of the pump?
2. What is the height of the pump from the base to the edge of the slope? What is the capacity of the pump, excluding the pyramidal top?

3. Find the area of the four sides of the trough; of the base. How many cubic inches of water will the trough contain?
4. Draw and cut out a rectangle 4″ × 1″, and divide as shown below.



(*a*) What is the area of the whole figure?

(*b*) Cut out the triangle B, and place it by A so as to form another triangle. Are the areas equal?

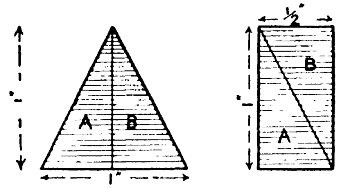
(*c*) Measure the line LM and LN; then ON and OP.

(*d*) Cut out the portion marked A, and by placing the two parts AB on the triangle LMN, compare the triangles. Test the other triangles in the same way.

(*e*) Using the part marked A, find an angle equal to the angle LMN. Test if this angle will exactly fit in the opposite angle LNM. How many angles in each of the triangles are equal to the angle LMN?

(Note that each triangle has equal sides and equal angles, and that the whole rectangle has an area of 5 sq. in., and elicit from the pupils that the area of each triangle is ½ sq. in.)

(*f*) Compare the area of the triangle and the rectangle formed by placing the two parts as shown.



Find the area of a triangle having a base of 4″ and a perpendicular height of 6″.

Make a rectangle containing 12 sq. in. and cut it into two equal parts, so as to form a triangle having a base of 4″ and an altitude of 6″.

5. Make a sketch of the finished model.

APPLICATION.

Discuss the construction and use of the pump.
If possible, show a working model.
Note the use of the trough.

8. The Windmill

CONSTRUCTION.

Proceed as in last model. Fasten the side flap first, and then the bottom.

Fold windows outwards.

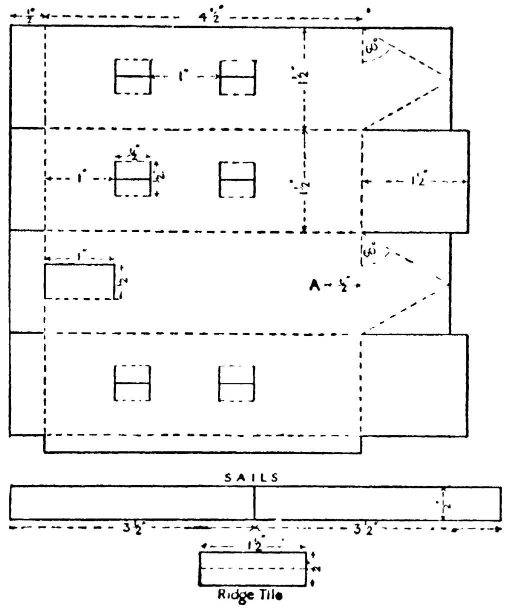
Paste sails at right angles to each other to form a cross, and then fix at point A. The roof and ridge tile may be coloured red before pasting.

EXERCISES.

1. Make a drawing of the completed model.
2. What is the area of all the windows? of the door? Find the area of the remaining portion of the sides of the windmill.

APPLICATION.

Discuss the use and motive power of the mill.



9. Sliding Match-box

CONSTRUCTION.

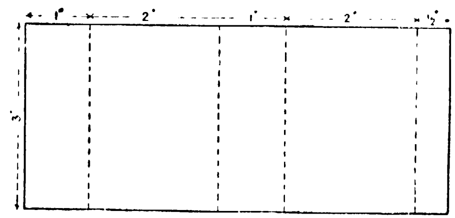
Completed specimens should be examined before the development of each part is drawn. The allowance of $\frac{1}{16}''$ in the width and height of the box will necessitate careful measurement, in order that a good fit may be secured.

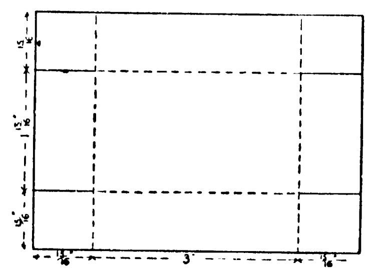
EXERCISES.

1. Find the area of the base of the box.
2. Find the volume of the box.
3. Find the area of each of the sides of the cover.
4. Find the internal area of the box.
5. How many square centimetres does the top of the cover contain?
6. What is the total area in square centimetres of all the four sides of the cover?
7. Make a hand sketch of the cover, and insert the measurements of all sides in centimetres and decimals of a centimetre.
8. Draw a plan and end elevation of the cover.

APPLICATION.

Make a sliding pencil-case. The length of the pen or pencil should be the standard of length.





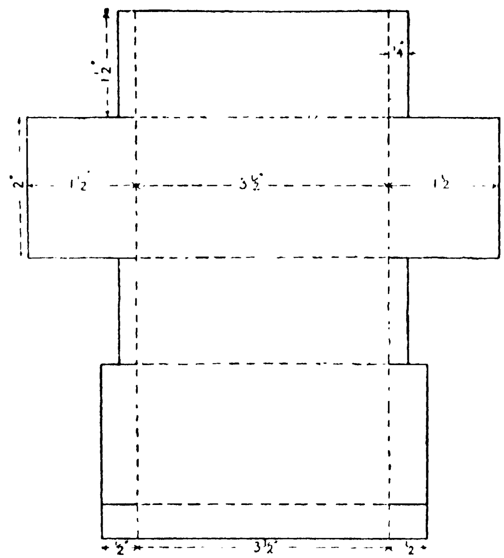
10. Box with Hinged Lid

CONSTRUCTION.

Draw the development. Cut and fold as indicated. In the drawing, the size of the lid is identical with that of the box. In order to secure a fit, it will be necessary to fold the box lines slightly inside the lines, and the lid lines slightly outside.

EXERCISES.

1. Make a sketch of the box—corner view—inserting all dimensions.
2. Find the area of the base.
3. Measure the height and find the volume.
4. Measure other boxes, and calculate areas and volumes.
5. How many inch cubes could be put into a drawer 8″ × 5″ × 4″? How many would there be in the top layer?



11. The Card Case

CONSTRUCTION.

An ordinary playing-card should be measured. The pupils will readily understand that some allowance should be made in the width of the box to enable the cards to slide in easily (⅛″). The length of the box should be identical with that of the card.

The thumb-hole should be drawn by using the 45° set-square.

Flap A should be fastened first.

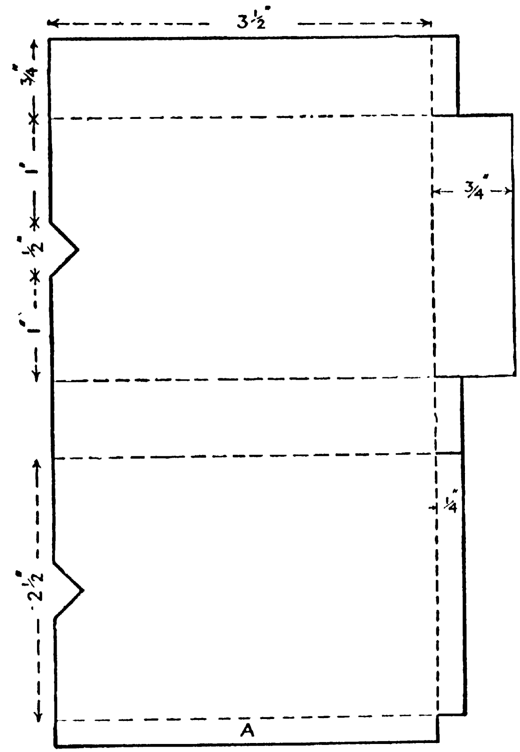
Place all flaps inside.

EXERCISES.

1. Form a square, using the pieces cut out for the thumb-hole; rearrange the two pieces to form one triangle. What kind of triangle is it? What is its area?
2. Draw a front elevation of the box.
3. Cut out a playing-card to fit the box.

APPLICATION.

1. Discuss the uses of the box; to keep the cards together; free from dust, &c.
2. The pupils should make a cover for the box, calculating the necessary allowance.



12. Blotting Pad

CONSTRUCTION.

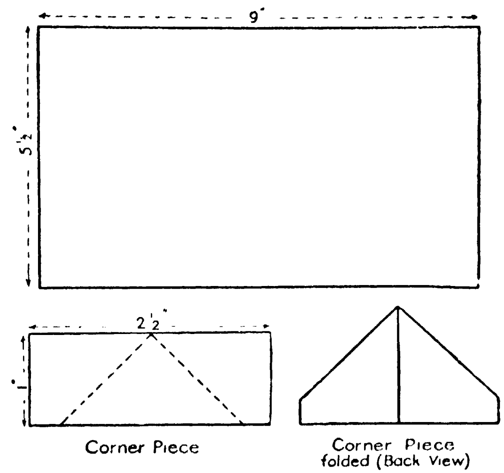
Supply each child with a few sheets of blotting paper of the size used in school, say 9″ × 5½″.

Cut a piece of brown paper the same size as the blotting paper.

Cut the four corner pieces, and fold as indicated in the sketch.

Place the blotting paper on the backing, and fix the corner pieces behind.

Fix the whole to a piece of thin card of equal dimensions.



13. Postcard Holder

CONSTRUCTION.

Material: Brown paper or thin card. Each child should be supplied with three or four postcards.

Cut a piece of paper the exact size of a card.

Cut the corner pieces, and fold as in last exercise.

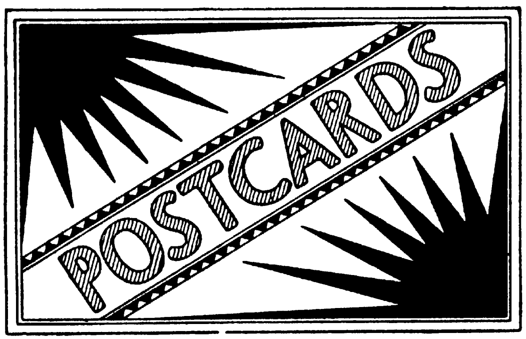
Place the cards on the piece of paper used as a backing, and paste the corner pieces behind.

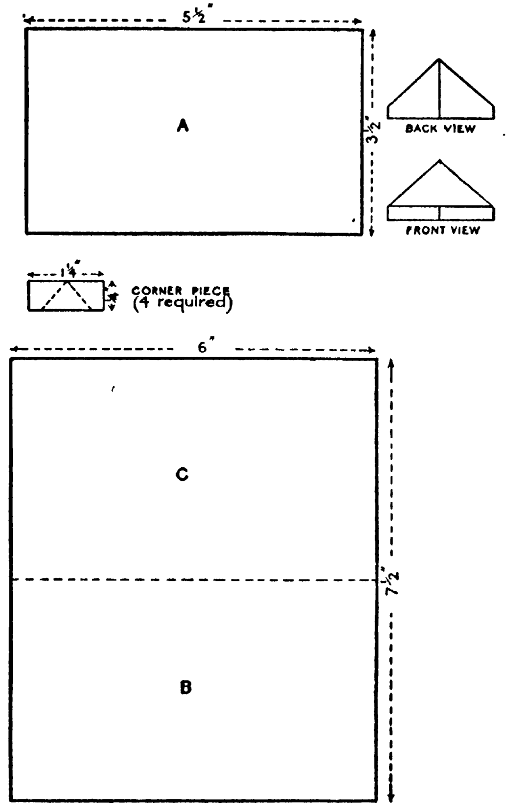
Cut out the cover $7\frac{1}{2}'' \times 6''$, and paste the back of the paper holding the cards centrally to the bottom half (B).

Cut a piece of blotting paper $5\frac{1}{2}'' \times 3\frac{1}{2}''$, touch the corners with paste, and fasten centrally to the upper part (C).

EXERCISE.

Make a suitable design in brush work for the front of the holder (see sketch).





14. The Grandfather's Clock

EXAMINATION AND PRELIMINARY EXERCISES.

Specimens should be distributed, and the pupils required to find the dimensions, first of the two end prisms, and then of the middle one. It will then be observed that the model is composed of three oblong prisms.

Ex.—Construct circles by using compasses of 2½", 2", and 1½" radius, and divide into six equal parts.

Bisect one of the arcs thus obtained, and step round with the same radius from the point of bisection.

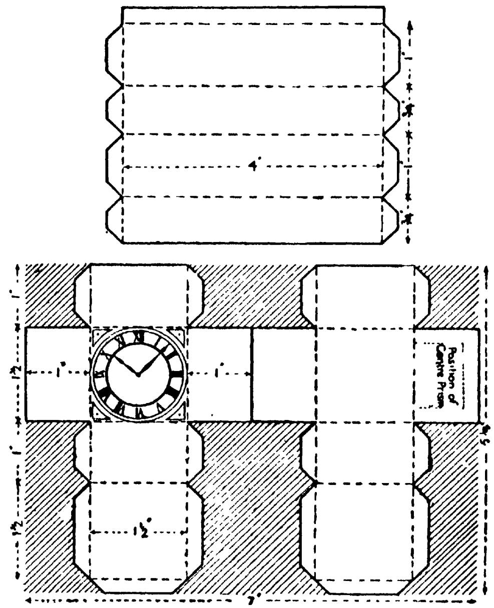
This gives the position of the figures on the clock face.

CONSTRUCTION.

This should offer no difficulty. It will be observed that the three prisms are flush at the back, and that the central prism is placed exactly ¼" from the three remaining sides of the top of the base.

EXERCISES.

1. Make a sketch of the clock. Note the figure IIII on the dial.
2. Make a suitable ornament for the top of the clock. (See plate p. 96.)
3. Find the total area of the top and bottom prisms. Compare with the central one.
4. Measure the sides of the base in centimetres (2·7, 3·8). Find the perimeter; the area (2·7 × 3·8 sq. cm.).



5. Find the perimeter of all the edges of the bottom prism.
6. If each long edge of the clock face is $3n$ cm. long, what is the perimeter of the face? what is the area?
7. If each short edge of the top prism is $2n$ cm. and each long edge $3n$ cm., what is the perimeter of all the edges of the top and bottom prisms? what is the total area?
8. If the lengths of the edges of the central prism are $3y$ cm., $4y$ cm., and $16y$ cm. respectively, (*a*) find the perimeter of all the edges; (*b*) find the area of the base, the front, the side.

15. The Fireplace

CONSTRUCTION.

The essential parts of this model consist of three oblong prisms; the two uprights being of equal dimensions, 4″ × 1″ × ½″, 3½″ × 1″ × ⅜″.

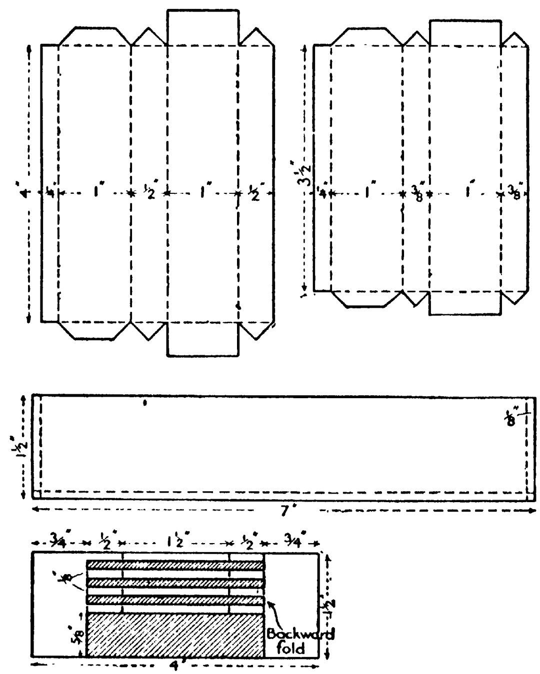
The mantelpiece is 7″ × 1½″, and has the front and side edges turned down, thus giving an appearance of solidity.

When the bars are fitted into the space, they should project a little from the back.

The uprights, cross-piece, and bars should be fitted to a piece of thin cardboard, 5½″ × 4″.

The base or hearth is formed of a piece of thicker cardboard, 5½″ × 1″.

The brackets or shelf supports are constructed from strips of paper, 7″ × ½″, rolled to form an "S"-shaped scroll.



EXERCISES.

1. Make a drawing of the completed model.
2. Measure the fireplace at home, and bring a dimensioned sketch.

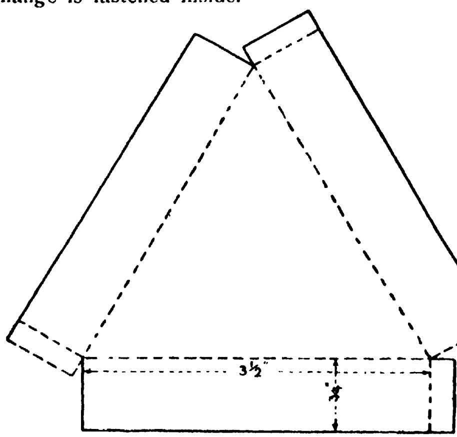
16. The Triangular Tray

(Rectangular Sides)

EXAMINATION AND CONSTRUCTION.

Cut open completed specimens, to show that the development consists of a rectangle, $3\frac{1}{2}'' \times \frac{3}{4}''$ on each of the three sides of the triangle.

A flange of $\frac{1}{4}''$ is added to each rectangle. The flange is fastened inside.



EXERCISES.

1. Find the length of all the edges of the tray.
2. Find the area of the three rectangular sides of the tray.

Area = $(3 \times 3\frac{1}{2} \times \frac{3}{4})$ sq. in. = $7\frac{7}{8}$ sq. in.

3. Draw an equilateral triangle, side $3\frac{1}{2}''$. Mark the centre of the base, and join to the apex.
   (*a*) How long is the line?
   (*b*) Find the area of the triangle.

   Area = $\frac{1}{2}bh$.

4. Each side of the triangle is approximately 6 cm. Test this statement. Each short side of the rectangle is 1·9 cm.
   (*a*) Find the perimeter of the three rectangles.
   (*b*) Find the area of a rectangle in square centimetres.

   $1 \cdot 9 \times 6 = 11 \cdot 4$ sq. cm.

5. Make a sketch of a rectangular side of the tray. Call each long side $7a$ in. long, and each short side $3b$ in. long.
   (*a*) Find the area of the rectangle.

   $(3b \times 7a) = 21ab$ sq. in.

   (*b*) Find the area of the three rectangular sides.

   $3(3b \times 7a) = 63ab$ sq. in.

   (*c*) Find the perimeter of the nine edges.

   $(7a \times 6) + (3b \times 3)$ in. $= (42a + 9b)$ in.

   (*d*) Find the difference in length between all the long edges and all the short edges.

   $(7a \times 6) - (3b \times 3)$ in. $= (42a - 9b)$ in.

17. Equilateral Triangular Tray

(Sloping Sides)

CONSTRUCTION.

Completed specimens should be distributed, and the pupils should be required to measure the triangular base. They should measure the size of the angles with their protractors.

The model should then be cut and opened out.

It will be easily elicited that the development is obtained by constructing an equilateral triangle of 6 in. side, and setting out as in diagram.

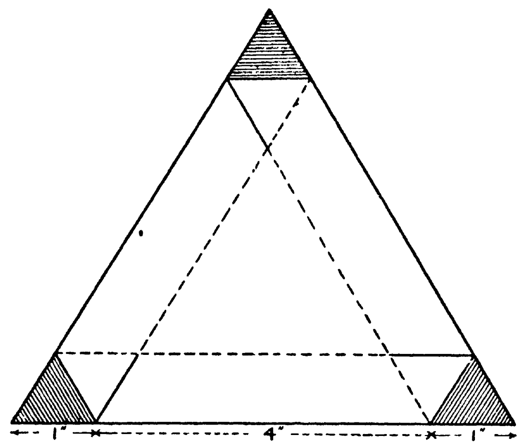
Attention should be called to the parallel lines, and the use of the set-square for drawing such lines should receive attention.

EXERCISES.

1. Find the perimeter of the bottom edges in centimetres and decimals of a centimetre.
2. Construct an equilateral triangle having its sides 10 cm. Join the centre of the base to the apex. Measure the altitude and find the area.

$a = \frac{1}{2}bh = (\frac{1}{2} \times 10 \times 7 \cdot 8)$ sq. cm. $= 39$ sq. cm.

3. Measure the length of the top edge of the tray. Construct an equilateral triangle having sides equal to this, and find the area in square centimetres.
4. If each edge of the triangular base is $5x$ cm., and each edge of the triangular top is $5y$ cm., and the other edges $2z$ cm., what is the total length of all the edges?



18. The Dovecot

EXAMINATION AND CONSTRUCTION.

The children should be asked to measure the edges of a completed model. It will be found that (*a*) the front and back are equilateral triangles; (*b*) that there are six equilateral triangular openings in the front; (*c*) that the base is a rectangle, 4″ × 1″; (*d*) that the two sides are rectangular, and are 1¼″ × 1″.

Call attention to the two end flaps in the base of the model. Let the pupils suggest what the flaps join to the base of the model.

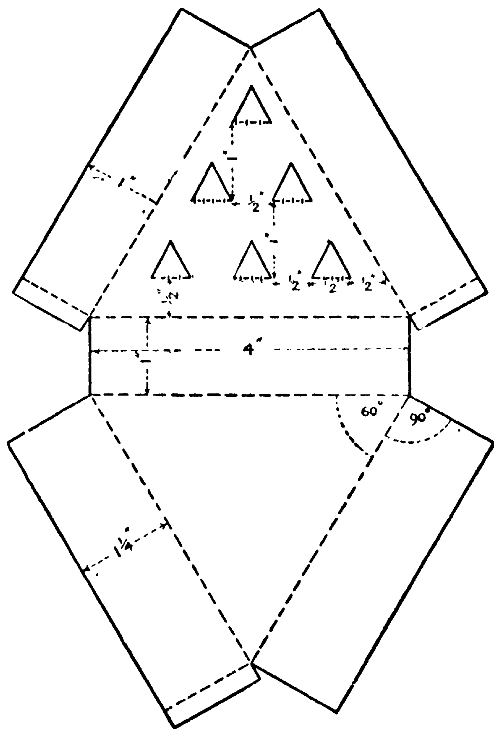
In this way, elicit that there are two rectangles, 4″ × 1″, bent backwards and fixed under the sides which are seen.

Note that the construction of this model forms a very valuable lesson on the use of the 60° set-square in the construction of equilateral triangles, and also in the use of the set-square for drawing parallel lines.

1. Begin with the rectangular base.
2. Construct the two larger equilateral triangles, using compasses.
3. Construct the rectangles as shown on each side. (Use set-squares.)
4. The rest of the triangles should be obtained by using the set-square to draw three parallel lines at the given heights.

The other sides are easily obtained by drawing lines parallel to each side.

Care will be necessary in cutting out the alighting boards.



EXERCISES.

1. Make a dimensioned sketch of the model.
2. Find the area of the three rectangular sides.
3. How many right angles are there? How many equilateral triangles? How many angles of 60°?
4. Construct a triangular upright with struts and proper base for supporting the dovecot.

---

19. The Triangular Prism

EXAMINATION AND CONSTRUCTION.

Completed specimens should be provided, one between every two pupils.

The children should be required to make statements as to the number of faces, edges, corners.

They should also test which angles are right angles and which acute.

It will be observed that the model has three rectangular sides and two triangular ends.

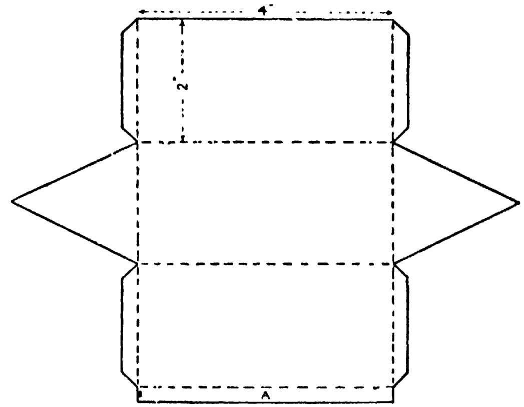
Recall the former lessons on the square prism and the rectangular prism, and contrast these with the model under consideration—the *Triangular Prism.*

Measure the length of the sides of the triangles.

The specimen models should be cut and opened out. (See development.)

The pupils will readily observe that it will be necessary in the first place to construct the three rectangles which form the sides of the solid, and then the equilateral triangles which form the ends.

Allowance is necessary for the flanges, which should be placed inside. Flange A should be fixed first.



EXERCISES.

1. Draw the development of a triangular prism having its rectangular sides 12·5 cm. × 6·4 cm., and the side of triangular ends 6·4 cm.
2. Find the total area of the three rectangular sides (12·5 × 6·4 × 3) sq. cm.
3. Find the area of the two triangular ends.
4. Find the total area.
5. A triangular prism has each of its long edges x'' in length, and the short edges y'' in length.
   (*a*) What is the area of each rectangle? of the three rectangles?
   (*b*) Find area of each triangle; of the two triangles.
   (*c*) What is the length of all the edges?

6. Complete the following statements: A triangular prism has edges, faces, corners.
7. What is the greatest number of faces, edges, and corners which can be seen at any one time?
8. Make sketches of the model from three different points of view.
9. Draw the development of a triangular prism having sides 4″, 4″, 1½″, and whose length is 2″.

 Such a prism is sometimes called a wedge.

20. The Right-angled Triangular Prism

EXAMINATION AND CONSTRUCTION.

The children should examine completed specimens, and be asked to compare this model with the last.

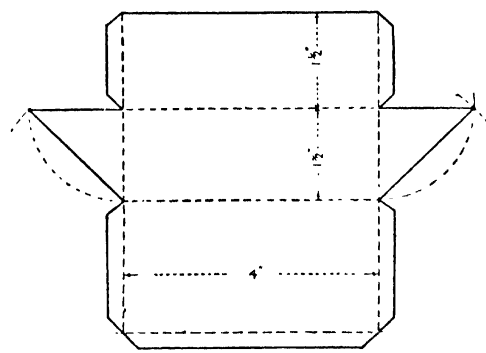
The triangular ends should be tested. Measure the lengths of the sides of the triangle. How many sides are equal?

Find, by using tracing paper or thin tissue paper, if any two angles are equal.

The pupils should be invited to suggest the method of setting out the development.

EXERCISES.

1. How many edges, corners, and faces has the model?
2. What is the total area of the two equal rectangular faces?
3. Find the total area of the two triangular faces.
4. (*a*) Construct two right-angled triangles having bases of 5 cm. and their altitudes also 5 cm.
 (*b*) Cut these out and place together, with the two right angles opposite to each other. What figure is formed? What is its area?
5. Place two completed models together, having their two largest faces touching each other.
 (*a*) What model is formed?
 (*b*) Find area of base.
 (*c*) Find the volume of the solid thus formed.
 (*d*) What would be the volume of the triangular prism?



21. The Scalene-triangular Prism

EXAMINATION AND CONSTRUCTION.

Completed specimens should be provided for examination as before.

The development may be found either by cutting open the model or by rotating, as in the previous exercise.

Ask the name of the triangle forming the ends.

EXERCISES.

1. What is the area of the smallest rectangular side?

   $(4 \times 1\frac{1}{2})$ sq. in. $=$ 6 sq. in.

2. Find the total area of the two other sides.

   $(3\frac{3}{4} \times 4)$ sq. in. $=$ 15 sq. in.

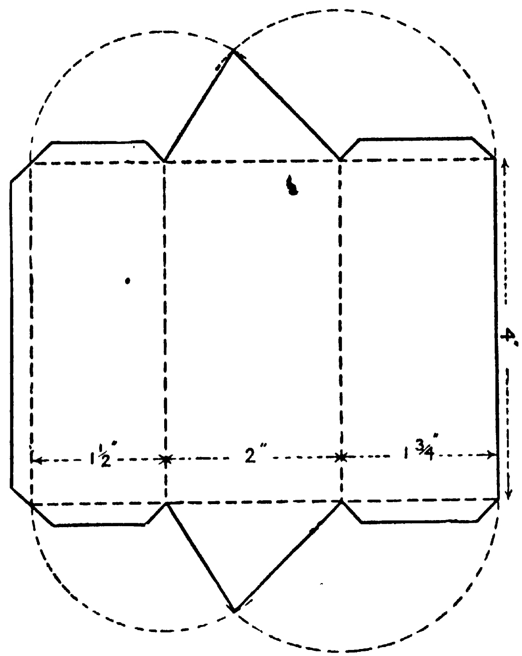
3. What would the area of the rectangular surfaces be, if the model were twice as high?

   $(5\frac{1}{4} \times 8)$ sq. in. $=$ 42 sq. in.

4. Construct a scalene triangle having sides equal to those of the triangular base of the prism. From the apex, drop a perpendicular to the base by means of the ruler and set-square.
   (*a*) Measure the altitude.
   (*b*) Find the area of the two triangular ends of the prism.

   Area of 2 triangles $= \frac{1}{2}bh \times 2$
   $= (\frac{1}{2} \times 2 \times 1\frac{1}{4} \times 2)$ sq. in.
   $= 2\frac{1}{2}$ sq. in.

5. Place two completed models together so that equal faces are touching each other exactly. Examine the solid thus formed, and make statements about the figure forming the base.



22. The Tetrahedron

EXAMINATION AND CONSTRUCTION.

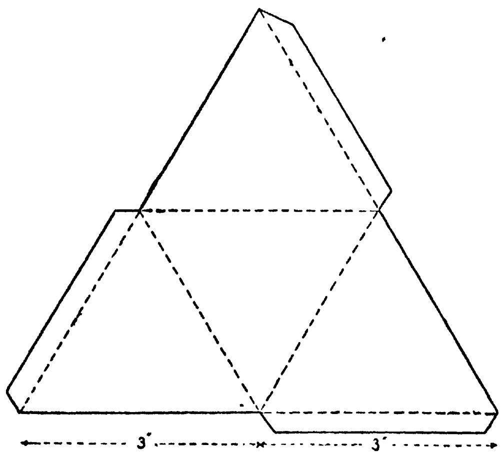
Open out a completed specimen by cutting down the oblique edges.

The development will be seen to consist of four equilateral triangles, forming equal parts of a large equilateral triangle.

Draw an equilateral triangle 6″ side.

Join the centres of the sides. Place flanges as shown.

Note alternative method of discovering development. Place the model on the centre of the paper, and trace round the basal triangle.



Rotate the model on each line thus drawn, tracing the edges in each case.

EXERCISES.

1. How many corners has a tetrahedron? edges?
2. What is the greatest number of faces you can see at one time?
3. Describe an equilateral triangle of 3 in. side.
   On one of the equal sides describe another equilateral triangle.

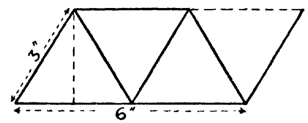


Fig 1.

   Measure each side of the figure thus formed.
   How does it differ from a square?
4. How many obtuse angles does the rhombus contain? How many acute?
5. Draw an equilateral triangle 6 in. side.
   Join the centres of the sides. (See development.)

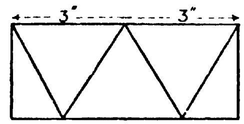


Fig. 2.

   Cut and arrange as in fig. 1.
   In the first triangle, join the apex to the centre of the base. Cut down the central line. Arrange as in fig. 2. Measure the height and find the area.

23. The Hexahedron

EXAMINATION AND CONSTRUCTION.

Each pair of pupils should place their models of the tetrahedron base to base. The resulting six-sided solid is called a "Hexahedron".

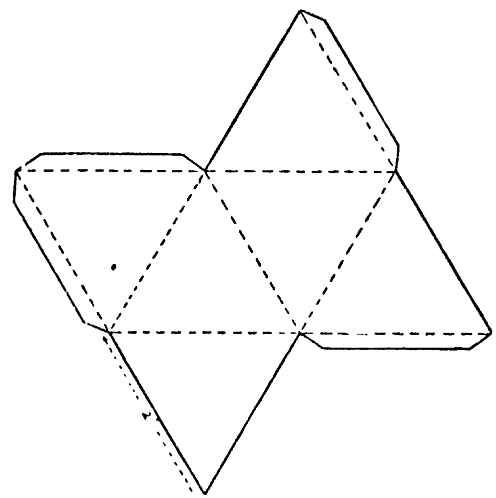
A completed model should be shown, and the pupils invited to explain how it is that a six-sided solid is formed when two four-sided solids are placed base to base.

The development presents no difficulty. It can easily be found by rotating, as in the last model, and adding two additional triangles.

N.B.—The triangle without flanges should be fixed last.

EXERCISES.

1. How many edges has a hexahedron?
2. How many corners has a hexahedron?
3. How many edges meet at each corner?
4. What is the greatest number of faces which can be seen at any one time?
5. Make sketches of the model in three different positions.



24. The Dog-kennel

CONSTRUCTION.

The development of this model is formed from a rectangle $5\frac{3}{4}'' \times 5\frac{1}{4}''$.

The completed specimen should be opened out, and it will be noticed that there are five equal rectangles, forming the base, sides, and roof of the kennel. The ends consist of a square and equilateral triangle in each case. The door consists of an opening $\frac{3}{8}'' \times \frac{1}{2}''$.

Flanges are cut for the two sides, but the roof projects $\frac{1}{4}''$ each end.

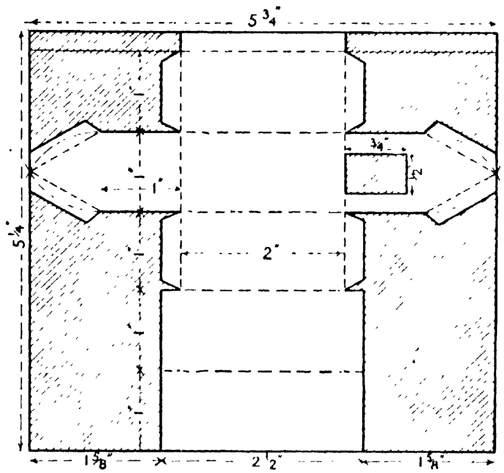
The sides should be fitted first with flanges inside. Bend in and paste all the roof flanges. Fix the roof, and hold till dry.

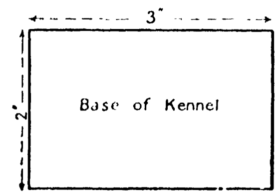
N.B.—Care should be taken not to bend in roof flanges too far.

The whole should be fixed to a base of thin cardboard, leaving a border of half an inch all round.

EXERCISES.

1. Make a sketch of the completed model.
2. What is the total area of the roof? Find the difference in area between two sides and the roof.
3. Find area of the door.





25. The Protractor

EXAMINATION AND CONSTRUCTION.

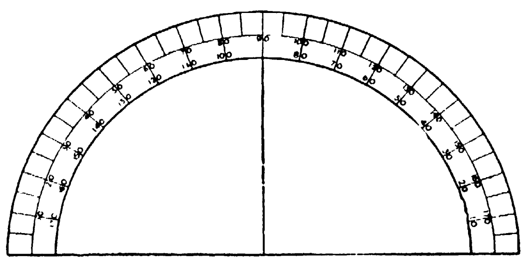
Completed specimens should be passed round the class for examination. It will be observed that the protractor has the following properties:—

1. It is in the form of a semicircle.
2. It is graduated from 0° to 180°, both in the clockwise and the anti-clockwise direction.
3. The centre is marked.

Recall previous lessons on angles, and the pupils will remember that up till now they have considered angles as being greater or smaller than "Right Angles". Explain the markings on the protractor.

Construct a semicircle 2½" radius.

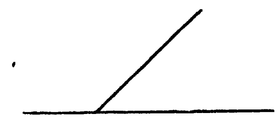
Bisect the arc. Trisect each of the right angles. Number the points of division 30°, 60°, 90°, 120°, 150°, 180°. Bisect a right angle. This gives 15°



which should be stepped off round semicircle. The intermediate points may be found by trial.

EXERCISES.

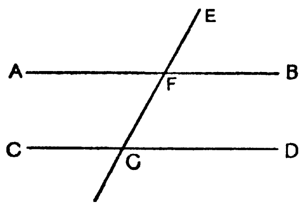
1. Give plenty of practice in measuring the sizes of various angles, such as those of the various triangular prisms, the hexagonal prism, and the angles on the set-squares.
2. Let pupils draw two lines touching as below.
   (*a*) Measure each angle.
   (*b*) How many degrees do they make together?
   (*c*) How many right angles is this equal to?



3. Draw four lines radiating from a point. Measure each of the angles. How many degrees do they make together?
4. (*a*) Draw two straight lines crossing each other, and measure the four angles so formed.
   (*b*) Repeat two or three times. Notice the opposite angles in each case.
5. Measure the shadow thrown by a 6-ft. pole at noon. On squared paper draw the lengths of pole and shadow to scale. Complete the triangle, and measure the angle of the sun's height above the horizon with the protractor. This exercise should be performed at regular intervals throughout the year.

6. Use the set-square to draw two parallel lines AB and CD, and a line EH crossing them.

(*a*) Compare angles EFB and FGD; AFG and FGD; AFG and CGH; FGD and CGH.
(*b*) How many degrees are there in the sum of EFB and BFG; AFG and BFG; BFG and FGD; BFG and CGH?



7. Make six triangles of different shapes. Call each ABC. Use the protractor to measure the angles, and complete the following statement.

Triangle.	Angle A.	Angle B.	Angle C.	Sum of all the Angles.
1.				
2.				
3.				
4.				
5.				
6.				

8. Use your protractor to draw angles of 50°, 80°, 120°.

9. Draw two straight lines of equal length at right angles to each other. Join their extremities. Find the size of the other two angles.

10. Draw a line XY 3½" long. At X draw a line XZ 3½" long, making an angle of 60° with XY. Join YZ. (*a*) How long is it? (*b*) Measure each of the angles of the triangle.

11. Through how many degrees does the minute hand of a watch turn in 1 min.; 5 min.; 15 min.; 35 min.; and 50 min.?

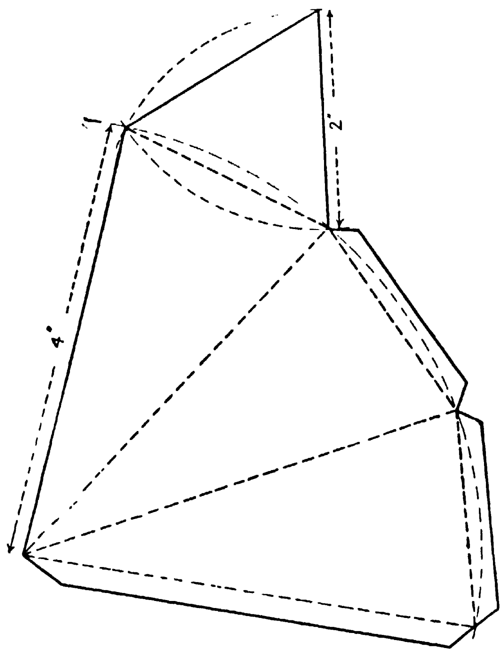
APPLICATION.

Give a lesson on the Mariner's Compass, and let the pupils construct a "Compass Card", showing all the points.

26. The Triangular Pyramid

CONSTRUCTION.

The method of obtaining the development may be discovered either by revolving the model on its sides,



or by cutting down one of the long sides and along two of the sides of the triangular base, and opening out.

The pupils should be required to measure the completed specimen models, and the construction should present little difficulty.

The long flap should be fastened first. All flaps should be placed inside.

EXERCISES.

1. Use the protractor to test the size of the angles of the various triangles. Describe the triangular sides of the pyramid.
2. How many corners has a triangular pyramid?
3. How many edges meet at each corner?
4. What is the perimeter of all its edges?
5. If each short edge is *a* cm. in length, and each long edge *a* + *b* cm. in length, what is the sum of all the edges?
6. Make a sketch of the pyramid in two different positions.
7. Construct pyramids having bases which are scalene triangles and right-angled triangles.

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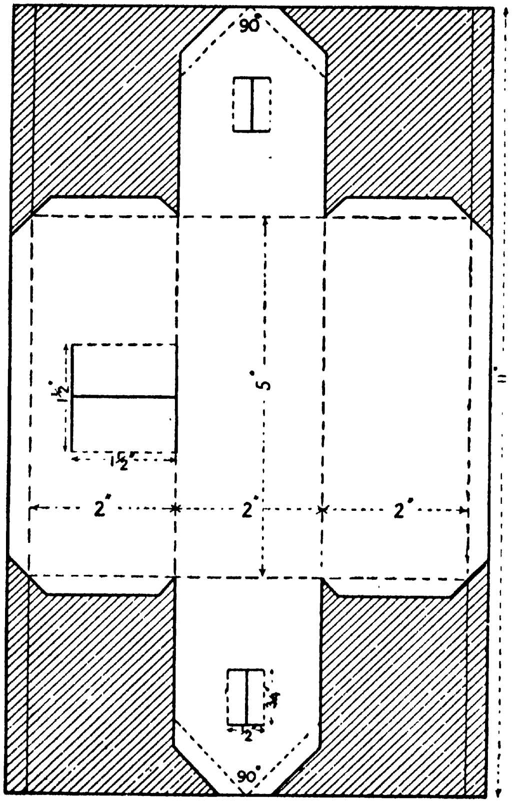
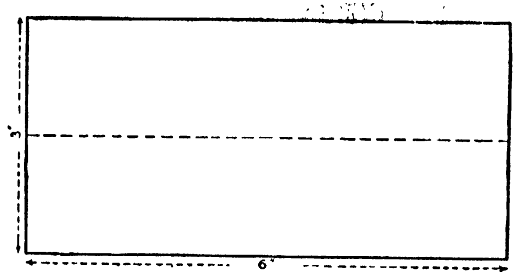
27. The Barn

CONSTRUCTION.

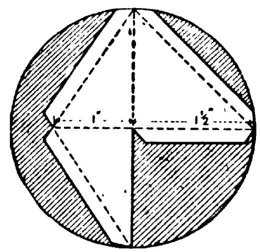
The floor and sides of the barn are cut out from an oblong 11" × 6½". The roof is an oblong 6" × 3", and projects ½" over each gable.

The secondary gables, which form a useful exercise in the consideration of the inclination of one plane to another, are modified tetrahedrons.





Roof of Barn



Gable of Barn
(2 required)

EXERCISES.

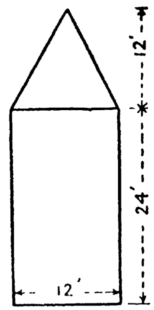
1. Make a drawing of the barn.
2. Find the areas of doors and windows.
3. Note size of doors. Give reasons for exceptional size: to allow wagons to enter, &c.
4. Why is the window capacity smaller than that of a house? (Windows for ventilation only—little light required.)

The gable end of a barn is 12 ft. wide and 24 ft. high to the roof. The height above the eaves is 12 ft.

(*a*) What is the area of the end?

(*b*) If it is 40 ft. long, how many square feet of floor boards will be required?

(*c*) What will be the area of the four rectangular walls?



28. Pentagonal Lamp-shade

EXAMINATION AND CONSTRUCTION.

An examination of completed specimens shows that the model has five long edges, and that the sides slope to five shorter edges.

Give the name pentagon; contrast with hexagon.

It will be noticed that one of the sides is pasted to exactly cover the next side.

The pupils will readily understand that the development will be formed by constructing a hexagon having a side of 3 in., and within and parallel to it, another hexagon, sides 1 in.

Cut along the thick line, and paste side A to B.

EXERCISES.

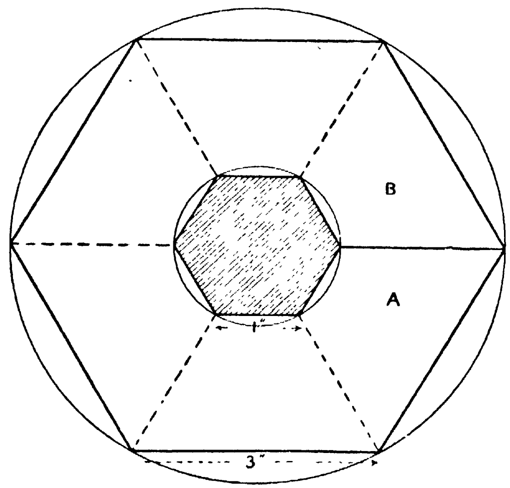
1. (*a*) Divide the hexagon which has been cut from the centre of the model into six triangles by drawing the three diameters.

   (*b*) Measure each of the angles, using the protractor; and then measure the obtuse angle formed by a short side of the model and one of the lines, dotted in the diagram.

   Compare the result obtained by adding two of the first angles and contrasting with the size of the obtuse angles.

   (*c*) Draw any triangle. Produce one of its sides. Using the protractor, test which two internal angles contain the same number of degrees as the angle formed by producing one side of the triangle.

2. Colour the inside of the shade green, and make a suitable brushwork design for the outside.



29. The Hexagonal Tray

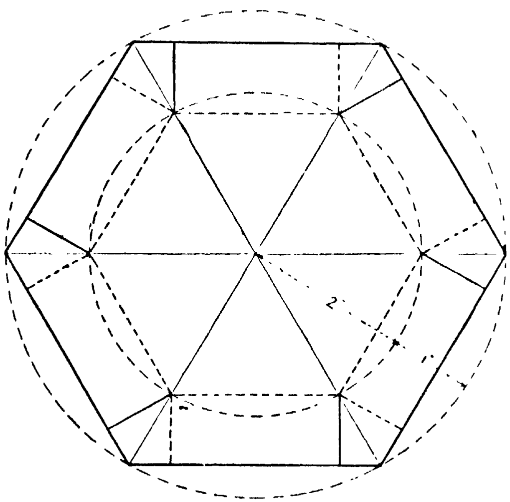
(Rectangular Sides)

EXAMINATION AND CONSTRUCTION.

It will be observed that the model is hexagonal in shape, and that all the sides are rectangular.

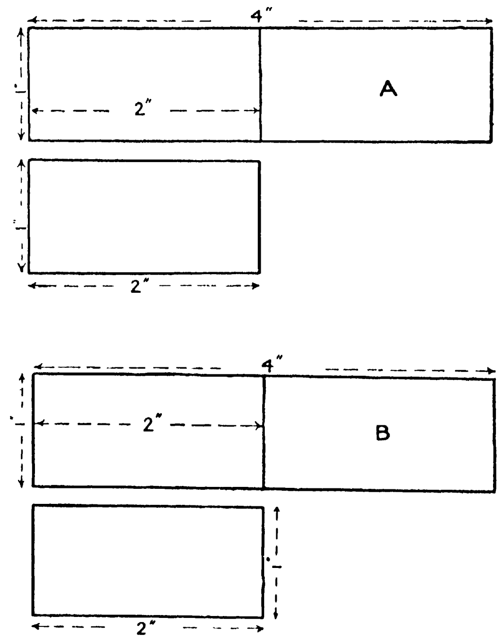
The pupils should be invited to discuss the method of drawing the development, and also the amount of paper which will be required for the model.

Great care will be necessary in the construction of the rectangles on the sides of the inner hexagon.



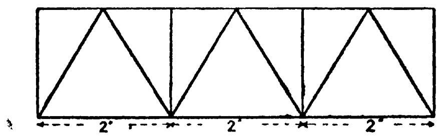
Divisions may be made in the tray by cutting out strips of the dimensions below. Cut A vertically half way, and insert in B.

All flaps should be placed inside.



EXERCISES.

1. Measure the number of degrees in each angle of the hexagon.
2. What is the total area of all the rectangular sides?
3. Construct a regular hexagon having sides of 2″, and join each alternate point to the centre.



   (*a*) What figures are formed?
   (*b*) Divide so as to show six equilateral triangles.
4. (*a*) Cut out the six equilateral triangles, and arrange as shown in the drawing.
   (*b*) Measure the height, and find the area of the rectangle.

---

30. The Hexagonal Tray

(Sloping Sides and Curved Edges)

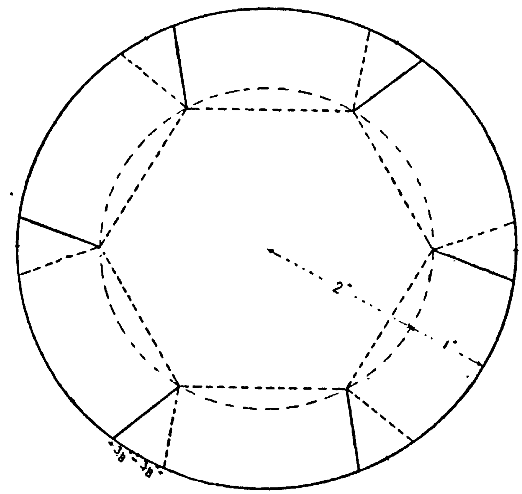
EXAMINATION AND CONSTRUCTION.

Contrast this model with the previous tray. Note the sloping sides and curved edges.

Open out a completed model, and invite pupils to find the radius of outer circle and the length of each side of the hexagonal base.

Note the method of obtaining flaps. Draw three diameters of the hexagon passing through the opposite angles. Produce these lines to the circumference of the outer circle. Measure 3/8″ on each side of each of the points in the circumference.

The flaps should be folded and cut as indicated. They should be placed outside.



EXERCISES.

1. Make a sketch of the model, and insert all dimensions.
2. Make a brushwork design for the bottom and sides of the tray.

31. The Hexagonal Prism

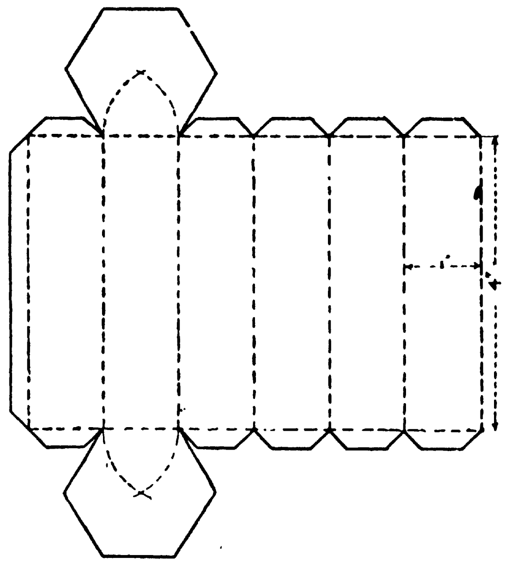
EXAMINATION AND CONSTRUCTION.

This model has six equal rectangular faces, and its two ends are regular hexagons.

The pupils should be required to measure the specimen models, and to set out the development without assistance.

EXERCISES.

1. What is the greatest number of faces which can be seen at one time?
2. How many corners has a hexagonal prism? how many edges?
3. How many angles are right angles? how many obtuse?
4. If a hexagonal prism has a face area of 10 sq. cm., and a volume of 95 cub. cm., find its height.
5. Measure the length of each edge in centimetres and decimals of a centimetre. Find the total length of all the edges.
6. If each short edge is $2x$ cm., and each long edge $(2x + 2y)$ cm., what is the total length of all the edges?
7. Make a sketch of the completed model.



32. The Hexagonal Pyramid

EXAMINATION AND CONSTRUCTION.

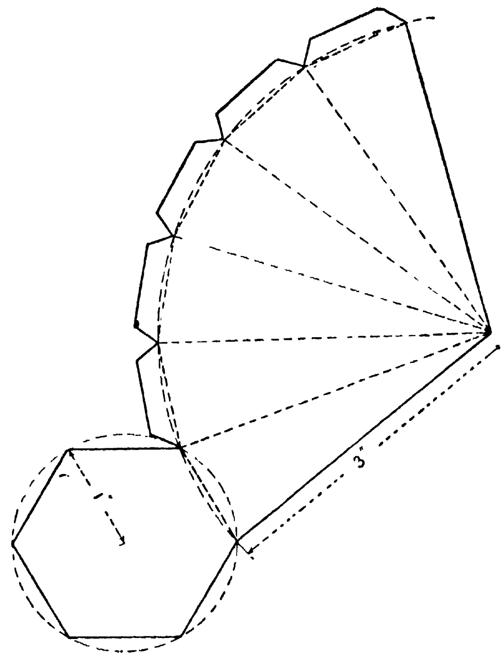
Examine the sides of the square prism, the hexagonal prism, the square pyramid, and the hexagonal pyramid. The regular prisms have equal rectangular faces, whilst the regular pyramids have, with one exception, isosceles triangular faces.

Examine the pyramids already made and find which pyramid has faces which are not isosceles triangles.

Questions should be asked as to the length of the edges, &c. The development presents no new difficulty

EXERCISES.

1. Test the triangular faces of the pyramidal models. How many degrees are contained by the angles of each triangle?
2. (*a*) Construct six isosceles triangles having two sides 3″ and a base of 1″.
   Cut one of the triangles as before, and arrange the whole to form a rectangle.
   (*b*) Measure the height, and find the area of the rectangle.
3. How many acute angles does the model contain? How many obtuse?
4. If a hexagonal prism had each of the six edges of the base $2a$ cm. long, and its other edges $5a$ cm. long, what is the total length of all the edges?



33. Hexagonal Lamp-shade

As this model is based on an Octagon, it will be necessary to show the method of constructing this figure.

The children should be provided with a paper circle, and be required to fold it into four equal parts. (Recall previous lesson dealing with the Quadrant.)

Let them suggest the method for dividing the circle by folding into eight equal *sectors*.

The octagon should then be completed and cut out.

Questions should be asked as to the number of degrees in each of the angles round the centre. The other angles should be tested by means of the protractor.

EXAMINATION AND CONSTRUCTION.

Completed specimens should be examined, and the pupils should be asked to suggest the method of construction. It may be necessary to state that the model is formed from two octagons. It will be observed that the central figure and one sector is cut out.

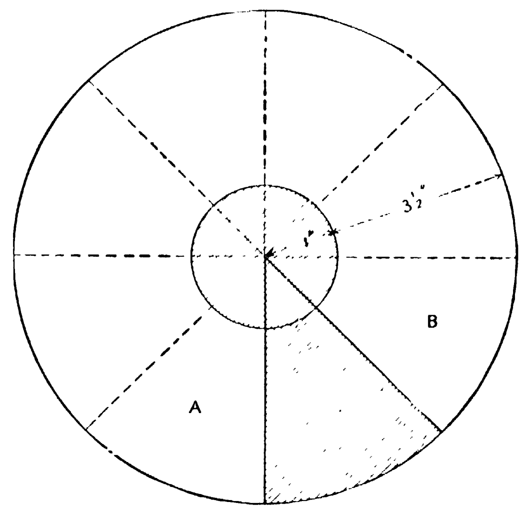
Paste sector A on B.
How many sides has the model?
How many sides to an octagon?

EXERCISES.

1. The model should be decorated with a brush-work design.
2. Find the perimeter of one of the faces of the model.
3. Make a sketch of the lamp-shade.

APPLICATION.

A lesson may follow on the "Trapezoid". Previous models may be examined, and the pupils asked to measure the dimensions of trapezoids.

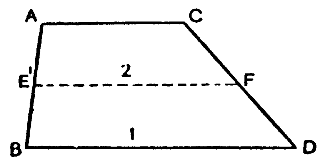


INVESTIGATION EXERCISES.

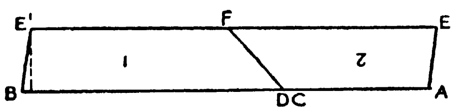
1. Make a rectangle equal in area to a trapezoid.

(1) Draw a trapezoid ABCD, and cut it out.

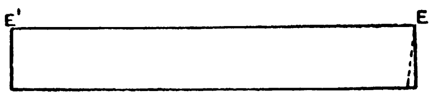
(2) Fold AC to meet BD, and cut along the middle line E'F.



(3) Place AEFC as shown, and drop a perpendicular from E'; cut along dotted line.

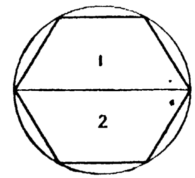


(4) Place as in last diagram.

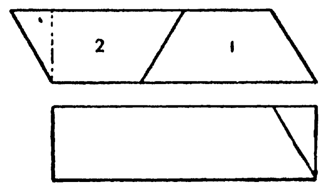


Find the area of a trapezoid.

2. Construct a hexagon. Draw the diameter, and so divide it into a double trapezoid.



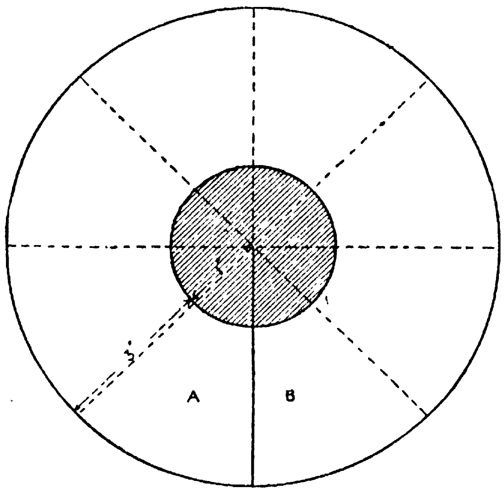
Make a rectangle equal in area to a hexagon.



34. Heptagonal Lamp-shade

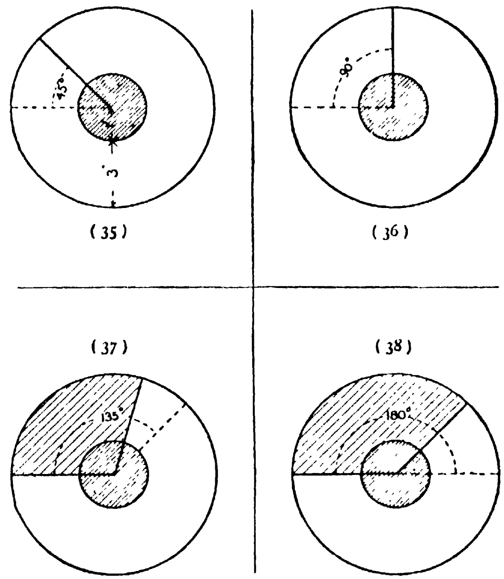
EXAMINATION AND CONSTRUCTION.

The construction of this model calls for no comment. It will be readily suggested by the pupils. A suitable brushwork design should be made on the outside after the inner circle has been cut out. Care will be necessary in cutting out the circle so that the edges are not left jagged.



35-38. Candle-shades

These four models form a good exercise on the principle of the cone. The children experiment by cutting angles of increasing size, and thereby discover that the greater the angle cut the steeper the slope of the frustum.



(35) (36) (37) (38)

Note in this case the model should not be folded along the dotted line. This indicates the limit of the area to be pasted after the cut has been made as shown.

In the case of Nos. 37 and 38 the whole of the area need not be pasted, the part shaded being cut out.

EXERCISE.

Any or all of these shades may be decorated with simple designs in brushwork or stencilling before being fixed (see examples in the illustration).

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39. Octagonal Tray

EXAMINATION AND CONSTRUCTION.

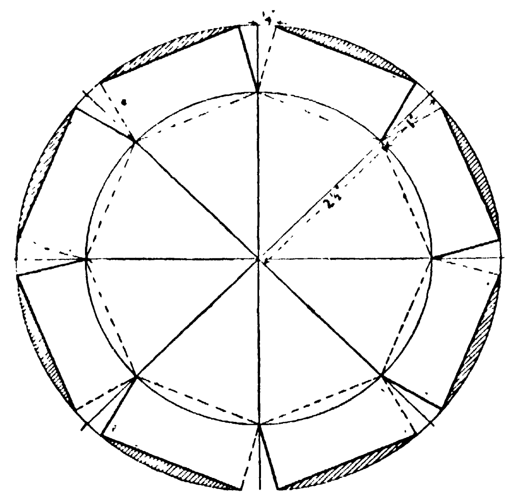
Completed specimens should be examined. The pupils should measure the diameter of the base and the height. This will give the necessary measurements for constructing the two concentric circles.

Construct the inner octagon first, and produce the radii of the inner circle to touch the circumference of the outer circle. Carefully measure ¼″ from each of the points so obtained, and join them to the sides of the inner octagon as indicated.

Note that the flaps form isosceles triangles. These should be placed outside. In making the cuts it is preferable to cut from the inside.

EXERCISES.

1. Make a suitable brushwork design for the inside of the tray.
2. Test the size of each of the three angles in one of the triangles shown in the development.
3. What is the total number of degrees contained in all the angles surrounding the centre of the octagon?
4. How many degrees are there in each of the angles formed by the junction of two sides?
5. What is the total perimeter of the top and bottom edges of the tray?
6. If each short edge is $2n$ cm. and each long edge $3y$ cm., what is the perimeter of all the edges?
7. Make a rectangle equal in area to an octagon.



Educational Handwork

Senior Course

J. L. MARTIN
AND
C. V. MANLEY

INTRODUCTION

The pupils, having had considerable practice in the use of the knife, have now arrived at the stage when cardboard work may be introduced. Exercises similar to those in the Intermediate Course may be re-worked, using medium cardboard instead of paper, thus giving experience in dealing with a stouter material. Stress should especially be laid on the necessity for the correct use of the knife in cutting. Great force is unnecessary. The knife should be drawn carefully along the line to be cut, without undue pressure, and there should be no attempt to cut the card at one stroke. The mechanical difficulty of keeping the knife close to the ruler edge whilst at the same time cutting through a line makes considerable demands on the child, and this can only be overcome by practice.

The knife should be always drawn *towards* the body, and the ruler should also point in this direction. Work with cardboard considerably restricts the movements of the child, and it is necessary that a few corrective exercises should occasionally be given during the lesson if much cramping work is being done.

To give command over the work the child will often find it preferable to stand whilst cutting.

Materials required for Senior Course

Cardboard:—

A medium cardboard (six-sheet) should be used in the earlier exercises. It should not be of a soft pulpy texture, but when scored should give a well-defined edge without creasing or fraying. Tinted card is preferable for the earlier models, and care should be taken in the selection of art shades, so as to add to the beauty of the models and develop the colour sense of the pupils.

Binding:—

Cloth strips — assorted colours. 11*d.* per 100, contract price.

Covering Paper:—

Geometrical models should preferably be covered with marble paper, but those which have a utilitarian or æsthetic value may be decorated with fancy papers.

The colours should be very carefully selected, as many of those at present on the market are crude and inartistic.

Lead Pencils:—

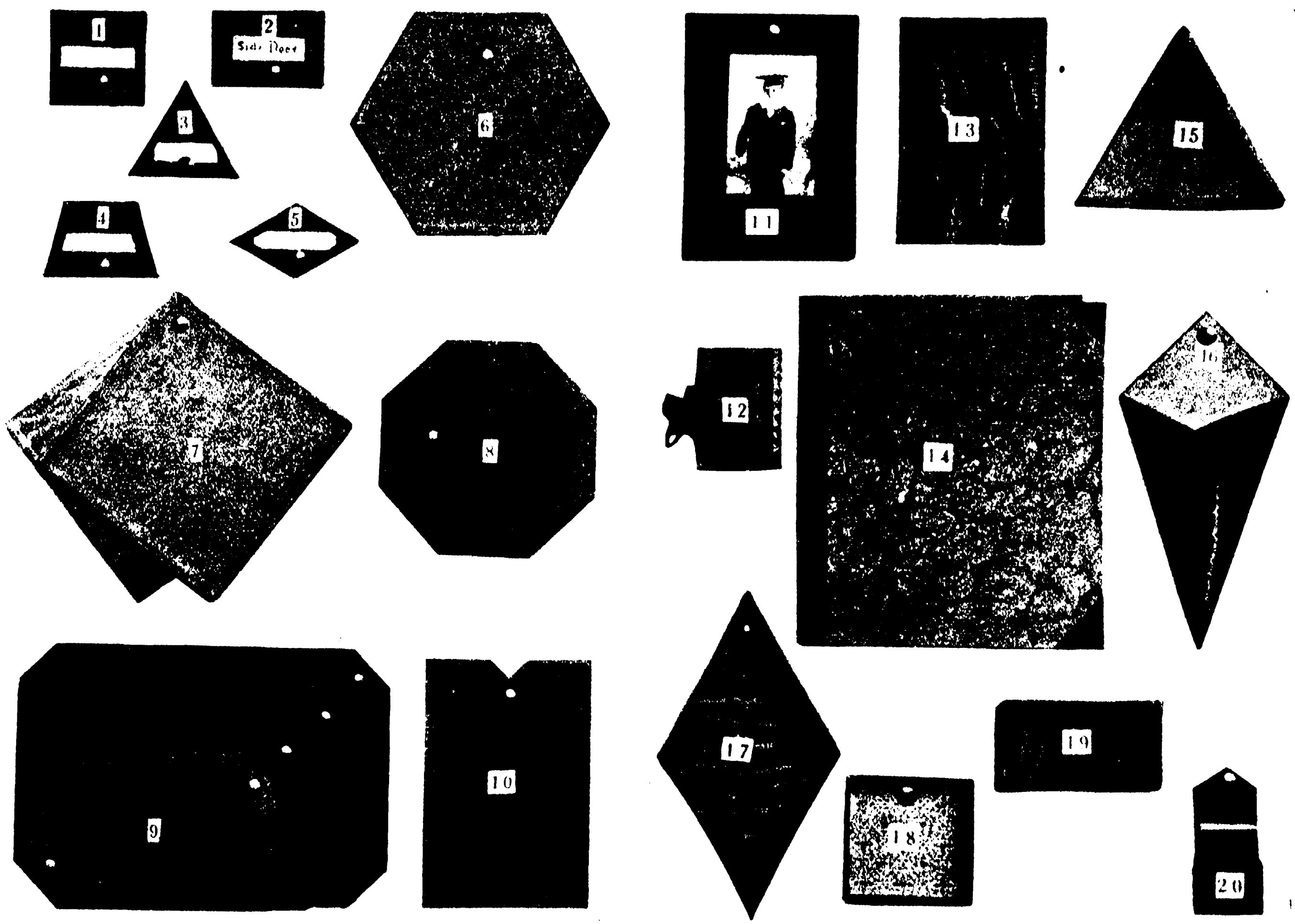
H or HH pencils should be used, as HB are too soft and do not give sufficient firmness of line. They should be sharpened to a chisel edge.

Gummed Cloth:—

This may be secured in various colours (36″ × 36″), treble gummed, at *1s.* a yard, or, if preferred, ungummed at *3d.* per yard cheaper. A neutral tint should be selected.

In choosing models for a cardboard course the objects made should be such as will serve a useful purpose, and should not be introduced merely as an exercise. Even in the earlier models in binding and covering geometrical figures the objects made are utilized as key labels, their different shapes, as well as the names on the labels, distinguishing the keys to which they belong.

MODELS FOR SENIOR COURSE—I



1. The Square. 2. The Oblong. 3. Equilateral Triangle. 4. Trapezoid. 5. Rhombus. 6. Hexagonal Lamp Mat. 7. Shaving-paper Tidy. 8. Octagonal Table Mat. 9. Table Mats. 10. Case for Savings-bank Book. 11. Photo Frame. 12. Needle Book. 13. Notebook Cover. 14. Portfolio for Foolscap Quarto. 15. Triangular Tray. 16. Hair Tidy. 17. Diamond-shaped Tray. 18. Square Tray. 19. Oblong Tray. 20. Hanging Match-box Holder.

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SENIOR COURSE

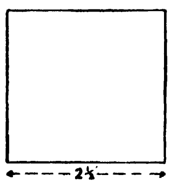
1. The Square

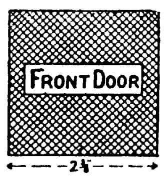
MATERIAL.

Cardboard, ruler, H pencil, set square, safety ruler, knife, scissors, binding strips, covering paper, and paste.

CONSTRUCTION.

Draw the square on the cardboard.[1] Cut out.





Covering Paper

BINDING.

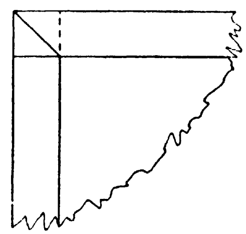
Cut two strips about ¼ in. longer than the edge of the square. Fold each strip accurately along the centre. Moisten the strips and fix on opposite edges of the figure.

The binding should be pressed well on to the edge of the square and gently smoothed from the centre outwards to exclude the air and superfluous gum. Cut off the waste ends flush with the sides.

MITRING.

Cut two other strips the exact length required. This is best done by placing the edge to be bound on the strip and marking off the length.

Fold along the centre as before. Place in position



[1] The pupils should be taught to avoid waste of material. They should cut from the side and not from the middle of the sheet of cardboard. A small figure like this should be cut from one corner. With each model the pupil should be required to exercise his judgment in this way.

without moistening, and with the knife press a line joining the external and internal angles of the binding (see figure).

With the scissors cut along the line; moisten and fix.

COVERING.

The covering paper should be of a size to overlap the binding to one-half its width. The child should be required to find the size of the covering paper by actual measurement. In this way differences in size owing to slight inaccuracies of the less skilful pupils are revealed, and each child is led to adapt the dimensions of his covering paper to the new conditions his error has created, in order to meet the requirement that the paper should overlap the binding to one-half its width.

An oblong $1\frac{3}{4}'' \times \frac{1}{2}''$ should be cut out of the centre of one of the covering papers.[1]

Examination and Criticism of the Models

The success of the work will largely depend on the way in which the finished models are tested and criticized by the teacher. No attempt should as a rule be made to do this during the progress of the lesson, as the ultimate aim of the work is to inculcate habits of self-reliance. Each model should be tested and criticized in the presence of its owner. For the earlier models the following plan has been adopted with considerable success. The model is criticized under five heads:—

1. Drawing	...	2	marks
2. Edges ...	...	2	,,
3. Corners	..	2	,,
4. Mitres ...	...	2	,,
5. Cleanliness	...	2	,,
		10	

1. **Drawing.**—Test for accuracy in size and angles by superimposing on the teacher's model.

2. **Edges.**—Rub a lead pencil along each edge. If the edges are hollow the binding bends over to one side.

3. **Corners.**—The cardboard should be completely hidden at the corners by the overlapping of the binding. Bad corners result from inaccurate measurement of the binding or badly cut mitres.

4. **Mitres.**—Errors in mitring result from bad marking or inaccurate cutting.

5. **Cleanliness.**—Soiled work need not be due entirely to dirty hands but may be caused by overmoistening of strips.

If this examination reveals the fact that a child has failed to grasp any particular point, the teacher should demonstrate the correct method to him.

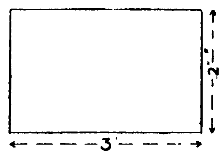
This plan places before the child a high standard of work. He perceives that perfection can only be secured by great attention to detail.

The knowledge that the model will be analytically examined acts as a deterrent to careless work.

[1] Suitable oblongs should be cut out of the centre of the covering paper in each of the models 1-5.

2. The Oblong

Proceed exactly as in last exercise.



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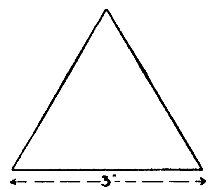
3. The Equilateral Triangle

CONSTRUCTION.

Construct with compasses an equilateral triangle on a base 3". Cut out.



BINDING.

Bind the first side flush at the ends.

The second side will be mitred at one end and flush at the other. The third side will be mitred at both ends.

COVERING.

Construct two equilateral triangles on the back of covering paper $2\frac{7}{8}$" side.

Cut out and cover as before.

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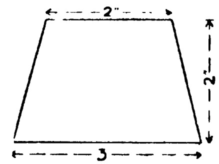
4. The Trapezoid

CONSTRUCTION.

On a base of 3" construct a trapezoid having a height of 2" and the opposite parallel side being 2".

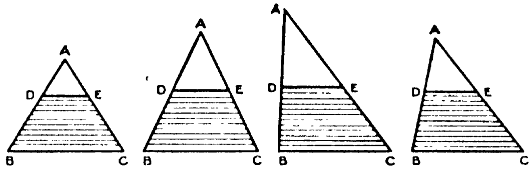


BINDING.

Bind opposite sides flush. Mitre the remaining pair of sides.

EXERCISES.

1. Draw in turn equilateral, isosceles, right-angled, and scalene triangles.
   Take a point D in the side AB of each triangle, and draw a line DE parallel to the base. Cut along DE in each case.
   The parts DBCE remaining are "trapezoids".
   Name the parallel sides of the trapezoid.



By superimposition compare the angles ADE with DBC in each case, and similarly compare angles AED and ECB.

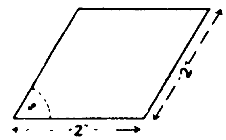
Observe that the lines AB and AC meet the parallels BC and DE, and that the corresponding angles ADE and DBC are equal, as also are AED and ECB in each case.

2. Draw parallel lines AB and CD any convenient length and say $2\frac{1}{2}''$ apart. Join AC and BD. Find area of figure.
3. Find the areas of the following trapezoids:—
   (*a*) Parallel sides 7 in. and 9 in.; height 4 in.
   (*b*) Parallel sides 220 yd. and 180 yd.; altitude 75 yd.
4. A field in the form of a trapezoid has its parallel sides 135 yd. and 175 yd. and the distance between them is 110 yd. How many acres does it contain?
5. If the area of a trapezoid is 48 sq. in. and the parallel sides are 5 in. and 7 in., what is the altitude?
6. If the area of a trapezoid is 48 sq. in. and the altitude is 6 in., what is the sum of the parallel sides?
7. Find the area of a trapezoid having its parallel sides a cm. and b cm. respectively and an altitude of c cm.

5. The Rhombus

EXAMINATION AND CONSTRUCTION.

The completed specimen should be examined and its dimensions and size of angles ascertained. The



side is $2''$ and the angles $60°$ and $120°$. (Compare with square.)

BINDING.

Bind opposite sides flush. Mitre the remaining pair.

GENERAL NOTE.

These five exercises contain all the methods necessary for mitring external angles, the rule being in every case to cut along the line joining the point of intersection of the edges of the beading and the corner.

TRIANGLES AND QUADRILATERALS

EXERCISES.

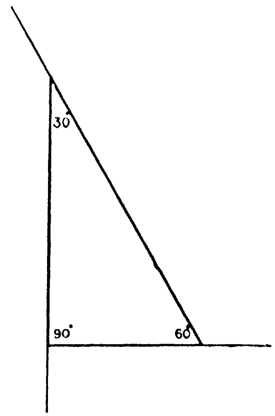
1. Construct an isosceles triangle having a base of $2\frac{1}{2}''$ and its equal angles 50° Measure the remaining angle.
2. Try to construct triangles having sides—

   (*a*) $2\frac{3}{4}''$, $1\frac{1}{4}''$, and $1\frac{1}{2}''$.
   (*b*) $3\frac{1}{2}''$, $1\frac{3}{4}''$, and $1\frac{1}{2}''$.
   (*c*) $4''$, $1\frac{1}{2}''$, and $2\frac{1}{4}''$.

   What does this teach you about the sides of a triangle?
3. (*a*) Draw two lines AB and AC at right angles to each other, each 7·5 cm. long. Construct an equilateral triangle ACD on AC.
   (*b*) Measure the angle BAD.
   (*c*) Construct another equilateral triangle BAE on AB. Measure each of the angles CAE, EAD, and DAB. (The right angle has been trisected.)

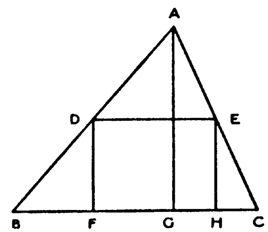
The teacher will now show the usual method.

4. Construct a right-angled triangle having two of its angles 60° and 30° respectively.
   Go round the triangle and produce the sides in the same direction.
   Find the size of the exterior angles.
   What is the total number of degrees in the exterior angles?
5. (*a*) Construct three triangles having one side $1\frac{3}{4}''$ long. Have they all the same shape and size?
   (*b*) Construct three triangles having two sides $1\frac{3}{4}''$ and $2''$ long. Have they all the same shape and size?
   (*c*) Construct three triangles having sides $2''$, $1\frac{1}{2}''$, and $1\frac{1}{4}''$. Cut two out, and test if they



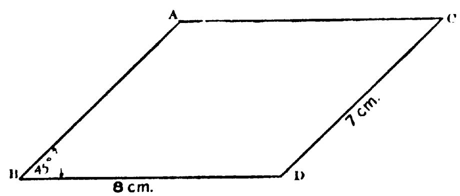
are equal to the other by placing them over it so that the sides correspond.
   (*d*) Construct three triangles having an angle of 45°. Are they the same shape and size?
6. (*a*) Draw a triangle ABC. Bisect the sides AB and AC in D and E. Draw lines perpendicular to BC from A, D, and E.
   Cut out the triangle ABC and fold along the lines DE, DF, and EH so that the points A, B, and C meet at G.

Compare the area of the rectangle DFHE and the triangle ABC.



(*b*) Try to construct a triangle having an area twice that of a given rectangle.

7. Construct a rhombus having—
(*a*) Diagonals 7·5 cm.
(*b*) One side 9·5 cm. and an angle of 30°.
(*c*) One side 8·4 cm. and a diagonal 10·8 cm.



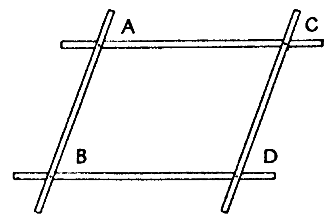
8. Construct the following parallelograms by means of ruler, set square, and protractor.
(*a*) Sides 7 cm. and 8 cm.; included angle 45°.
(*b*) Sides 3 in. and 4½ in.; included angle 60°.
(*c*) Sides 8 cm. and 12 cm.; included angle 75°.
(*d*) Sides 2·5 in. and 4·4 in.; including angle 80°.
Examine each of the figures, construct and complete the following table.

	Length of Sides.				Size of Angles.				Length of Diagonals.	
	AB	CD	BC	AD	ABC	ADC	BAD	BCD	AC	BD
(*a*)										
(*b*)										
(*c*)										
(*d*)										

(1) Compare the opposite sides and angles in each case.

SUPPLEMENTARY EXERCISE.

Cut four strips of cardboard and bind them together with paper fasteners so as to form a parallelogram



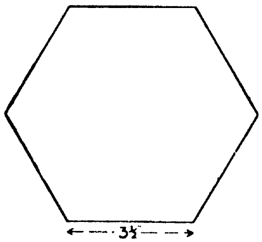
ABCD, the fasteners being at A, B, C, D, and acting as joints.

It will be found that the model may be moved in any direction without altering the distance between the sides.

6. Hexagonal Lamp Mat

EXAMINATION AND CONSTRUCTION.

Let children examine the completed model and make observations as to shape, size, &c.



Construct the hexagon $3\frac{1}{2}''$ sides. Cut out.

BINDING.

Bind alternate edges flush. Mitre the remaining three edges.

COVERING.

Each child should be required to obtain from his own model the diameter of the circle in which to construct the hexagon on the covering paper. This is obtained by measuring the distance between opposite angles of the model from the centre of the binding on each side.

Use leatherette for upper side and marble paper for lower.

EXERCISES

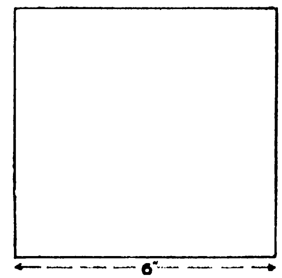
1. (*a*) Use the protractor and measure the angle contained by two sides of a hexagon.
   (*b*) Find the sum of all the internal angles.
2. (*a*) Construct a regular hexagon.
   From the centre O divide so as to form six equilateral triangles.
   (*b*) Find the sum of all the angles round the centre.
   (*c*) How many right angles are equal to the sum of all the angles of the hexagon together with those round the centre?
3. Construct a regular hexagon having a base of $3''$. Divide as before into six equilateral triangles. Cut out the triangles and arrange so as to form a parallelogram. Find the area.
4. Draw an equilateral triangle on a base 10 cm. long. Drop a perpendicular AD from the vertex A on the base BC. Measure the length of AD. What part is it of the base?
   Call the base B and the perpendicular H.
   Write down a rule for the area of the triangle.
   Area $= \frac{1}{2}$ BH or $\frac{1}{2}$ HB.
   ,, $= \frac{1}{2}$ B $\times$ ·858 B (a constant ratio).
5. Find area of equilateral triangles having sides of 6, 8, 10 inches respectively.

7. Shaving-paper Tidy

CONSTRUCTION.

Construct two 6-in. squares. Bind and cover. The holes in the corner should be punched when the model is completed.

A number of pieces of thin white paper, 5″ square, should be placed between a string or silk cord passing through a hole punched in the corner to correspond with the holes in the squares.



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8. Octagonal Table Mat

EXAMINATION AND CONSTRUCTION.

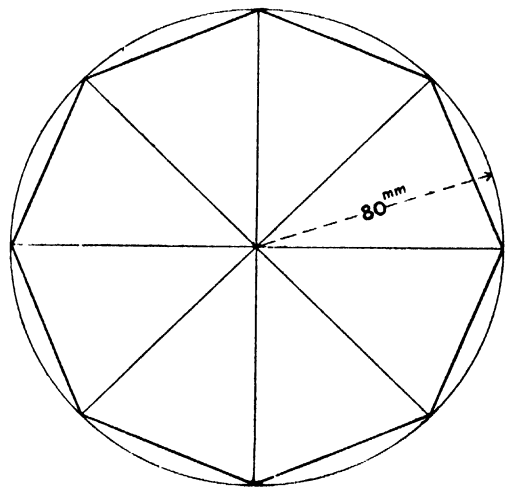
Examine the model and make observations as to size and number of sides, angles, &c.

Inscribe an octagon in a circle having a radius of 80 mm.

BINDING AND COVERING.

Bind opposite sides flush. Mitre the remaining four sides.

As before, the measurement for the covering-paper development should be taken by each child from his own model



9. Table Mats

(Set of Four)

EXAMINATION AND CONSTRUCTION.

Examine the completed models. The children will see that no binding has been used on the edges of these mats.

Measure length and breadth and also the amount cut away at the corners. Construct the oblong and cut off the corners.

COVERING.

Draw on the back of the covering paper an oblong the same size as the model.

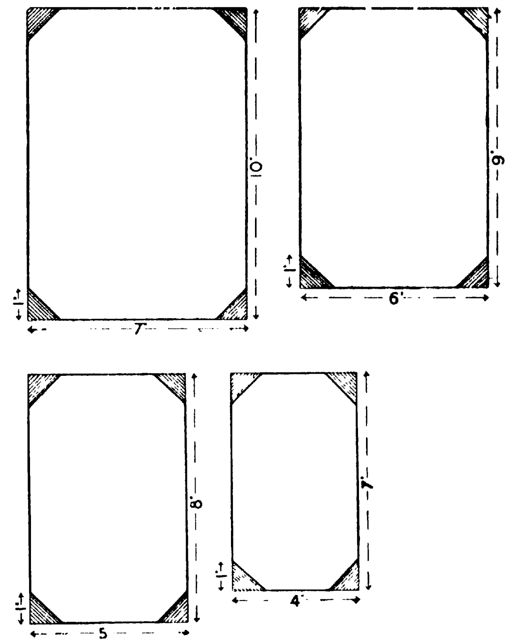
Outside this oblong draw lines parallel to the sides ½″ distant.

Cut the corners as in diagram, and paste.

The covering paper for the under side should be ¼″ less in length and breadth than the model, so as to leave a margin of ⅛″ all round.

EXERCISES.

Find the area of each mat.

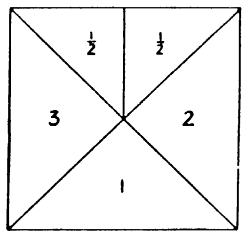


AREA OF REGULAR POLYGONS

(The Circle the Limit of the Polygons)

EXERCISES.

1 Construct a square, and draw the diagonals. Divide one of the triangles as indicated. Cut



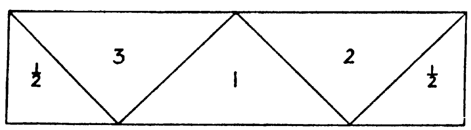
out the triangles, and arrange them so as to form a rectangle (see fig. below).

The base of the rectangle = $\left\{\begin{array}{l}\frac{1}{2}\text{ perimeter (P) of}\\ \text{the square.}\end{array}\right.$

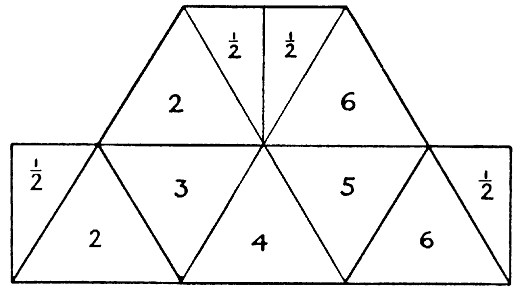
The height of the rectangle = $\left\{\begin{array}{l}\frac{1}{2}\text{ height (H) of}\\ \text{the square.}\end{array}\right.$

The area of the rectangle = $\frac{1}{2}$ P × $\frac{1}{2}$ H.

A = $\frac{1}{2}$ P × $\frac{1}{2}$ H.



2. Construct a hexagon. Join the opposite points, thus forming six equal triangles. Divide one

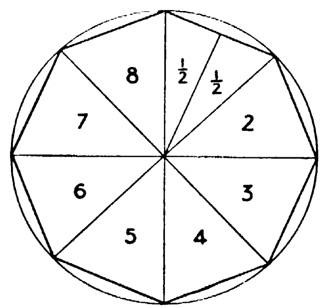


of the triangles as indicated. Cut out and transpose the parts as shown.

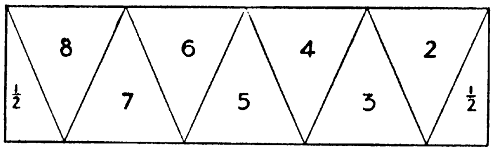
The base of the rectangle = $\left\{\begin{array}{l}\frac{1}{2}\text{ perimeter of the}\\ \text{hexagon.}\end{array}\right.$

The height of the rectangle = $\left\{\begin{array}{l}\frac{1}{2}\text{ height of the}\\ \text{hexagon.}\end{array}\right.$

The area of the hexagon = $\frac{1}{2}$ P × $\frac{1}{2}$ H.



3. Construct an octagon. Join the opposite points,



thus forming eight equal triangles. Divide one of the triangles as indicated.

Cut out and arrange the various parts as shown.

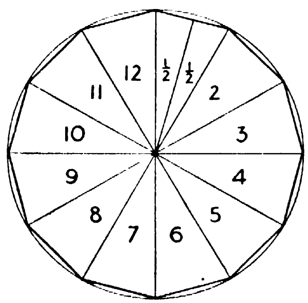
The base of the rectangle $=$ { ½ perimeter of octagon.

The height of the rectangle $=$ { ½ height of octagon.

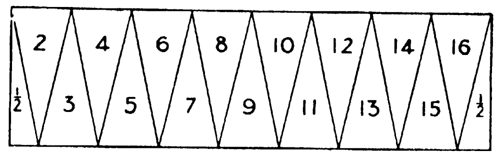
The area of the octagon $=$ ½ P × ½ H.

4. Construct a regular twelve-sided figure. (Divide the circle into four equal parts, and trisect each right angle.)

The base $=$ ½ P.
The height $=$ ½ H (of twelve-sided figure).
Area $=$ ½ P × ½ H.



5. Describe a circle on some thin, coloured paper. Cut it out and fold four times, so as to make sixteen sectors. Cut out the sectors and arrange as indicated.



The base of the rectangle $=$ { ½ perimeter of the circle.

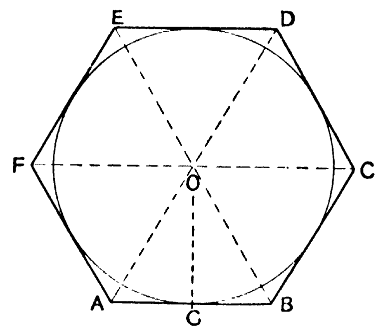
The height of the rectangle $=$ { ½ height of the circle.

The area of the rectangle $=$ ½ P × ½ H.

A $=$ ½ P × ½ H.

ALTERNATIVE METHOD.

Let ABCDEF be a regular hexagon. Join each angular point to the centre O. Six equilateral

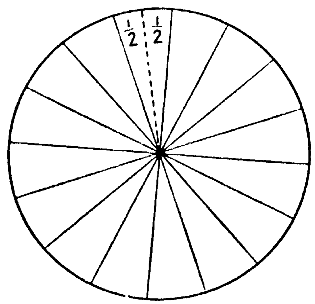


triangles are obtained. Six times the area of one triangle will give the area of the hexagon.

Area of ABO $= \frac{1}{2}$ BH.
Area of the hexagon $= 6$ ($\frac{1}{2}$ BH) $= 3$ BH.

The height equals the radius of the inscribed circle.
∴ Area of hexagon = (radius × half the perimeter).

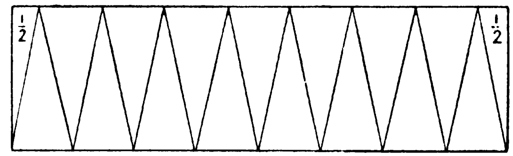
$$A = \tfrac{1}{2} PR.$$



General Case:—
In a figure of n sides:
Area of the triangle $= \frac{1}{2}$ BH.
Area of n^{gon} $= \frac{1}{2}$ BH $\times n$.
$= \frac{1}{2}$ B$n \times$ H.
$= \frac{1}{2}$ perimeter × radius ($\frac{1}{2}$ PR).

In the circle n becomes very large, and b becomes very small, but nb still = perimeter.
∴ Area $= \frac{1}{2}p \times r$ or $\frac{1}{2}rc$ (c = circumference).
These exercises establish a general rule for the areas of regular polygons.

Lessons should now follow on the construction of the various polygons and in finding areas.

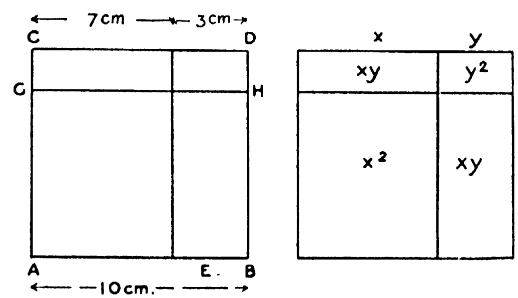


COMBINATIONS OF SQUARES AND RECTANGLES

Identities (I)

INVESTIGATION EXERCISES.

1. On a piece of thin card describe a square ABCD having a base of say 10 cm.
   Cut out the square.



Divide AB into two parts:

$AE = 7$ cm. and $EB = 3$ cm.

Draw EF parallel to BD and AC, and GH parallel to CD and AB.

Cut out the figures FH and GE.

Examine the four parts of the whole square. Which parts are equal?

What kind of figures are FH and GE?

The square on AB = the sum of GE, FH, GF, and EH.

$$10^2 = 7^2 + 3^2 + 2(7 \times 3).$$

2. Cut out another cardboard square having a total length of $(x + y)$ times same unit of length. Draw parallels as before. It will be observed that –

$$(x + y)^2 = x^2 + y^2 + 2xy.$$

(*Note to Teacher.*—Exercises should follow on the application of the preceding, the pupils being required to find the squares of numbers within the limits of 13 to 129 mentally.)

3. Take a piece of thin card and cut out a square LMNO having a side of x units.

Cut from this a smaller square having a side of y units.

The remainder equals the difference between two squares, or $x^2 - y^2$.

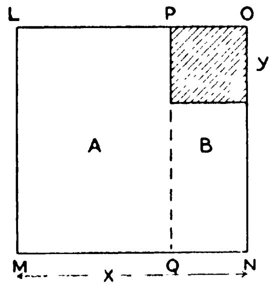
Draw PQ parallel to LM.

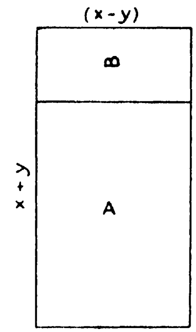
Cut along the line PQ. Mark the rectangles A and B, and arrange as below.

It will be observed that the difference between the two squares equals a rectangle having one side = to $x + y$ and the other to $x - y$.

$$\therefore x^2 - y^2 = (x + y)(x - y).$$

4. Cut out two cardboard squares, one (the greater)



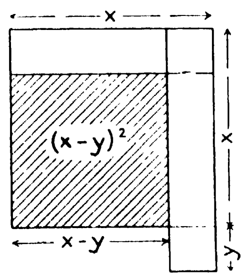


having a side of x units of length, and the other a side of y units of length.

Cut out in paper a square having a side of $x - y$ units.

Paste this on the larger square as shaded portion, and it will be seen that—

$$(x - y)^2 = x^2 + y^2 - 2xy.$$



APPLICATION.

Examples:—

$37^2 = (30+7)^2 = 30^2 + 7^2 + 2(30 \times 7).$
$= 900 + 49 + 420 = 1369.$
$47^2 = (50-3)^2 = 50^2 + 3^2 - 2(50 \times 3).$
$= 2500 + 9 - 300.$
$= 2209.$
$35^2 - 26^2 = (35+26)(35-26) = 61 \times 9 = 549.$

EXERCISES.

1. Find the squares of the following numbers:—
   31, 28, 36, 47, 92.
2. Find the answers to the following:—
   $57^2 - 22^2$; $38^2 - 19^2$; $46^2 - 32^2$; $132^2 - 56^2$.
3. Find the results of—
   67×32; 58×37; 32×17.

Identities (II)

(Partial Products)

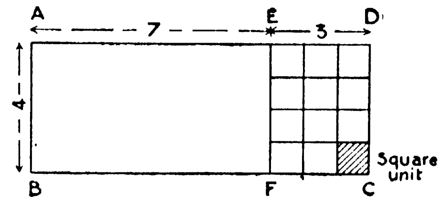
In working the following exercises it will be found advisable to provide each child with a piece of centimetre paper. He should be allowed to choose his own units. This admits of ready verification, and he is much more likely to completely understand the "generalized form".

$$4(7+3) = (7 \times 4) + (3 \times 4).$$

EXERCISES.

1. (*a*) Construct a rectangle ABCD 10 cm. by 4 cm. From D, along AD, mark a point E, 3 cm. On DE construct DEFC, and indicate the square units.

The area ABFE $= (7 \times 4)$ square units.
,, ,, EFCD $= (3 \times 4)$ square units.
The whole ABCD $= (7 \times 4) + (3 \times 4)$ square units.
$= 28 + 12.$



The single product $4(7+3)$ has been broken up into two *partial* products $(7 \times 4) + (3 \times 4)$.

(*b*) Use this same illustration to show that—

$$4(10-3) = (4 \times 10) - (4 \times 3).$$

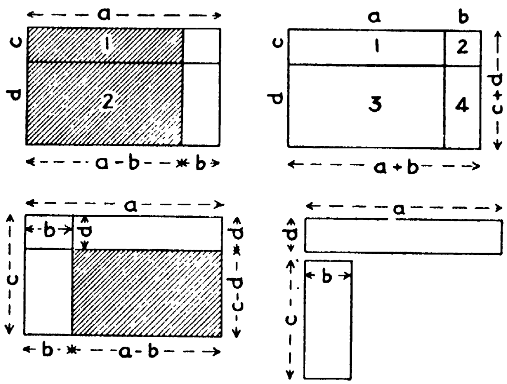
(*c*) Find the results of—

$3(5+3)$; $4(6+5)$; $9(a+3)$; $4(a+b)$;
$4(7-3)$; $6(5-2)$; $8(a-3)$; $5(a-b)$;
$a(b+c)$; $b(2a+3c)$; $3a(2b-3c)$.

2. Cut out a rectangle having sides of $(a+b)$ and $(c+d)$ units, and divide as below.
   Cut out the rectangles 1, 2, 3, 4.
   Rect. 1 $= ac$ square units; 2 $= bc$ square units; 3 $= ad$ square units; 4 $= bd$ square units.
   $\therefore (a+b)(c+d) = ac + bc + ad + bd.$

3. Cut out a rectangle having sides of $a - b$ and $c + d$ units (see shaded portion in the diagram), and divide as indicated.

$$\text{Rect. (1)} = ac - bc.$$
$$\text{,, (2)} = ad - bd.$$
$$\therefore (a - b)(c + d) = ac - bc + ad - bd.$$



4. Cut out a rectangle having sides of a units and c units.

In a take a part b, and in c take a part d. Complete the rectangles as under.

The shaded portion $= (a - b)(c - d)$.

To demonstrate that $(a - b)(c - d) = ac - bc - ad + bd$, cut out the shaded portion; rectangle $(a - b)(c - d)$.

In coloured paper cut out two rectangles having sides of a units and d units and c and b units respectively.

Place these over the unshaded portions of the first rectangle. The portion representing bd overlaps, which indicates that the area covered or *taken away* is too great by bd; $\therefore$ bd must be added to obtain the correct result when rect. $(a - b)(c - d)$ is taken from rect. ab.

Rect. $(a - b)(c - d)$ = The whole $ac - bc - ad + bd$.

This result is very important, as it indicates clearly that no matter what value we attach to the letters $abcd$, the product of the terms bd will give a *positive* result.

APPLICATION.

Find results.

1. $(x + 1)(x + 2)$; $(x + 1)(x - 2)$; $(x - 1)(x - 2)$.
2. $(x + 3)(x + 4)$; $(x + 3)(x - 4)$; $(x - 3)(x - 4)$.
3. $(2n + 1)(2n + 3)$; $(2n + 3)(3n - 4)$; $(2n - 3)(3n - 4)$.
4. $x(x \times 3)$; $x(2x - 3)$; $2x(3x - 4)$.
5. $-x(x + 3)$; $-x(2x - 3)$; $-2x(3x - 4)$.

10. Case for Savings-bank Book

EXAMINATION AND CONSTRUCTION.

Let the children find the dimensions of a post-office savings-bank book. These are 6¾" × 4". Discuss with them the need of an allowance for easy fitting. ½" in the width and ¼" in length will be sufficient.

Examine the model to ascertain the method of construction.

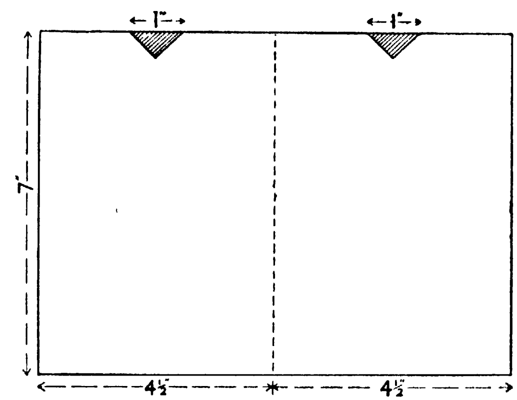
Draw the development on this cardboard; score and cut out as indicated. Mark the position of the slot, and cut out.

Fix together with binding strips round the three sides.

Bind the edges of the top, and cover both sides with leatherette or other suitable covering paper.

ADDITIONAL EXERCISE.

Let the children bring club cards, &c., and construct cases from their own dimensions.



11. Photo Frame

EXAMINATION AND CONSTRUCTION.

Measure carte-de-visite photograph (4½" × 2¾").

Discuss the amount of margin to be covered to allow a good view of the picture. In the case of this model the opening in the frame shows (3½" × 2¼").

This allows for margin of ¼" each side, and ½" at the top and bottom.

A completed model, showing all the parts clipped together, should be examined. It will be seen that the frame consists of four pieces of cardboard each measuring 5¾" × 4¼".

Draw the development and cut as directed in the diagram.

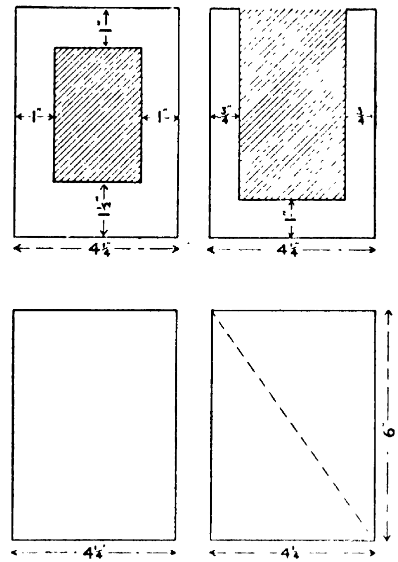
COVERING.

1. Cover one side of the front A in leatherette or fancy paper.
2. Paste pieces B and C together.
3. Cover the back of piece C with marble paper.
4. Cover the back of support O with marble paper.
5. Paste piece A to the two pieces B and C already fixed together. This leaves a space in which to slip the photograph.
6. Paste one-half of support to the back of the frame, leaving the other half free as a support.

Note.—This support is equally useful for either a vertical or horizontal picture.

This frame may be adapted to a picture or photograph of any size.

There are many variations to the mode of finishing and decorating this frame. The edges, external and internal, may be bound and the space decorated by a design in brushwork or stencil.



The front piece may be varied in shape, e.g. as a painter's oval palette; the internal opening may be square, oval, circular, or have round corners, according to taste.

EXERCISES.

1. (*a*) Find the area of one piece of cardboard.
   (5¼" × 4¼") =
   (*b*) Find the area of the part cut out.
   (3½" × 2¼") =
   (*c*) Find area of the margin.
2. A picture frame is 2 ft. long and 1 ft. 6 in. broad. The frame itself is 3 in. broad. Find the total area of the frame, and also the area of the picture able to be seen.
3. Make a drawing to represent a grass plot surrounded by a path of uniform width: length of lawn, 16 yd.; breadth of lawn, 13 yd. 1 ft. 6 in.; breadth of path, 4 ft. Find (i) the area of the lawn, (ii) the area of the ground covered by the lawn and the path, and (iii) the area of the path.

12. Needle Book

EXAMINATION AND CONSTRUCTION.

Examine a completed model, and thus obtain the dimensions and method of construction.

Each pupil will require, in addition to the cardboard, a piece of bookbinder's cloth 4½" × 1¼".

Cut out two pieces of cardboard 3½" × 2½".

Bind the two short edges and one long edge on each piece.

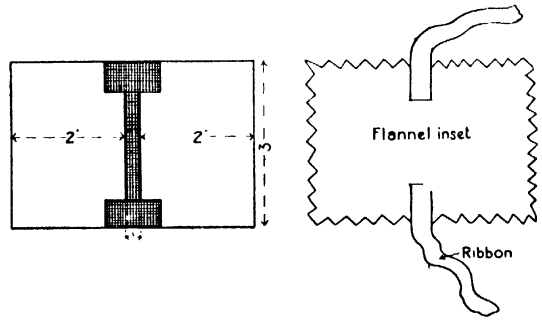
Draw lines on the cloth parallel to the long sides ½" from each edge.

Mark off ½" from each end.

Paste the cloth and lay the pieces of cardboard on it, so that the edges of the cardboard coincide with the lines drawn on the cloth.

Bend over the ends and press them well into the space between the two pieces of cardboard.

Paste a piece of cloth or covering paper, 3" × 1¼",



on the inside, pressing it well into the space between the two pieces of cardboard.

Cover the outside with suitable paper, and the inside with marble paper (size, 3¼" × 2¼").

Cut out pieces of flannel 3" × 4". Fold in two, and cut two slits in the back of the fold.

Thread a piece of narrow ribbon, 12" long, through the slits, and tie the flannel into the book, finishing with a bow at the back.

13. Notebook Cover

MATERIAL.

Cardboard, covering paper, bookbinder's cloth, half-sheets of drawing paper (six for each pupil), darning needle, and length of thread (12″).

EXAMINATION AND CONSTRUCTION.

Examine the completed model.

It will be observed that the method of binding the two parts together to form the book cover is the same as in the previous model.

The new exercise presented in this model is the covering of the corners with bookbinder's cloth.

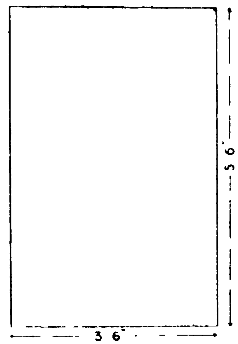
Cut two pieces of cardboard 5·6″ by 3·6″. Bind the corners as indicated in diagram.

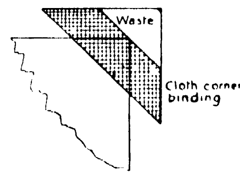
Join the two pieces with bookbinder's cloth as in last exercise, omitting the inner strip.

COVERING.

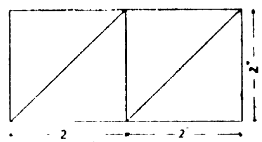
Mark on the back of the covering paper an oblong equal in size to the cover. Allow a margin of ½″ for overlapping on three sides.

Cut the covering paper as shown. Place the covering paper in position ·2″ away from the back edge of the card. This allows a sufficient amount of overlapping to cover the edges of the cloth-bound corners.





Method of fixing cloth corners



Bookbinder's cloth for corners

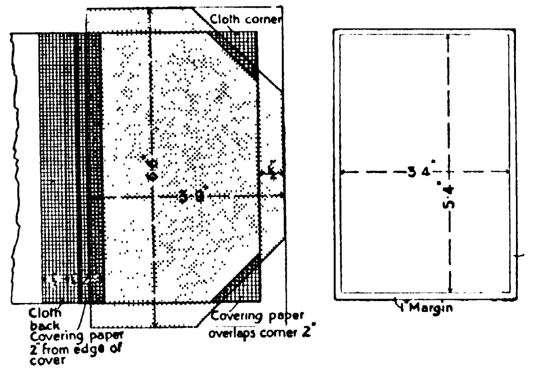
STITCHING THE NOTEBOOK.

Fold the sheets to be put in the cover across the centre. With needle make a hole through the centre and one each side of the centre about 2″ distant.

Pass the needle through the centre, retaining about 2″ of thread; then through the top hole, across the centre hole, through the bottom hole and through the centre. This brings the two ends together on the same side at the centre hole with the thread joining the top and bottom holes between them. Tie the two ends together tightly, and cut off spare thread.

Note. Before tying, make sure that the ends of the threads are on different sides of the thread passing from the top to the bottom holes.

Paste the outside pages of the notebook to the inside of the cover. Place under a press to dry.



14. Portfolio for Foolscap Quarto

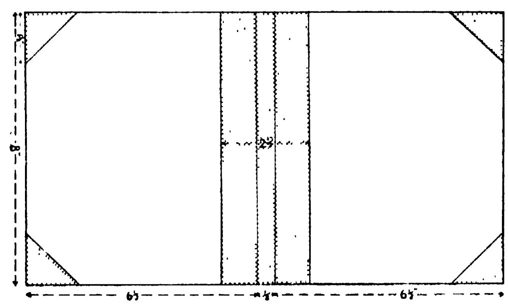
(Or Reading Case for Magazine)

This exercise is a special case based on the last exercise. The method of procedure is the same, the model differing only in size.

The portfolio is designed to contain papers of the size of an ordinary school exercise book.

Similar portfolios may be designed to hold music, a magazine, a set of maps, &c.

The decoration of the cover by brushwork design or a simple stencil may be left to individual taste.



15. Triangular Tray

EXAMINATION AND CONSTRUCTION.

Let pupils examine the completed model and make observations as to its shape, size, and construction.

Construct an equilateral triangle having a base 5″. On each side construct a rectangle 1″ in height. Score along the dotted line.

BINDING.

1. Bind the external corners flush.
2. Bind the internal corners flush.
3. Bind the top edges, mitring at each end.
4. Bind the bottom edges, mitring at each end.

COVERING.

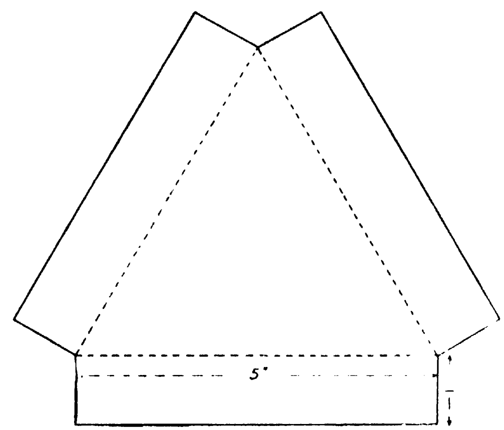
1. *Outside.*—Cut out three pieces 4⅞″ × ⅞″ for the rectangular sides. This is most economically done by constructing a rectangle 4⅞″ × 2⅝″ and dividing laterally into three equal parts. Construct an equilateral triangle with 4⅞″ side for the bottom of the tray.

2. *Inside.*—Cut out three pieces 4⅞″ × 1⅛″ for the rectangular sides. Paste in so as to allow a margin at the top of ⅛″ and a lap over the bottom of ¼″.

Construct an equilateral triangle of 4¾″ and paste in.

EXERCISES.

1. Find the sum of all the external edges of the tray.
2. Find the total area of the three rectangular sides.
3. Find the area of the triangular base.



16. Hair Tidy

EXAMINATION AND CONSTRUCTION.

Let pupils examine the completed model, and also one held together by clips, which may be opened out to show development.

The base of this model is a square. All the pupils need not necessarily work to the same dimensions. Draw development, score, and cut out.

BINDING.

1. Cut a strip 6″ long. Fold along the centre. Cut the binding half across at the middle point.

With this piece of binding bind the top edges, first fixing the binding firmly on one side. Then bring the other into position and fix. The binding of the top edges with one piece of binding instead of two holds the front edges together while they are being bound, and also gives additional strength to the model.

2. With a piece of binding 6″ long bind the two together.

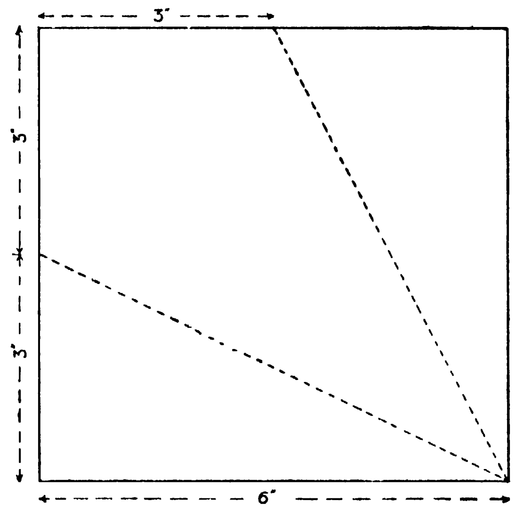
3. Bind the scored lines.

4. Bind the edges of the wall piece.

Note.—Carefully follow the rules for mitring.

COVERING.

Cover the spaces seen, allowing the usual margin. The internal covering at the back should extend far enough into the model to cover the space seen from the front.



EXERCISE.

Draw the development carefully on a piece of drawing paper. Join the extremities of the lines scored in the model. Find the area of each triangle, and compare the total area with that of the original square.

17. Diamond-shaped Tray

EXAMINATION AND CONSTRUCTION.

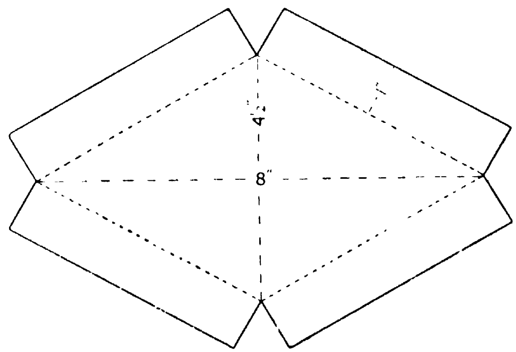
Let children examine the finished model. The following observations will probably be made:—

1. The model has equal sides.
2. The opposite angles are equal, ∴ the shape of the bottom is a rhombus.
3. The lengths of the diagonal are 8″ and 4½″ respectively.
4. The diagonals bisect each other at right angles.
5. The rectangular sides are 1″ high.

With this data the pupils can construct the rhombus.

After this has been done, construct a rectangle on each side 1″ high.

Score along the dotted lines.



BINDING AND COVERING.

Proceed exactly as in the case of the Triangular Tray (Model 15).

Note.—The rhombus, which is the base of this model, may be constructed alternatively, given the length of the side and the size of the angles.

EXERCISES.

1. Find the area of the bottom of the tray.
2. Find the total area of the four rectangular sides.
3. Find the sum of the twelve external edges if each long edge is $a + b$ cm. and each short edge b cm.

18. The Square Tray

19. The Oblong Tray

EXAMINATION AND CONSTRUCTION.

The method of setting out the development of both these models should present no difficulty. Let the pupils discover the development by examining the model.

BINDING.

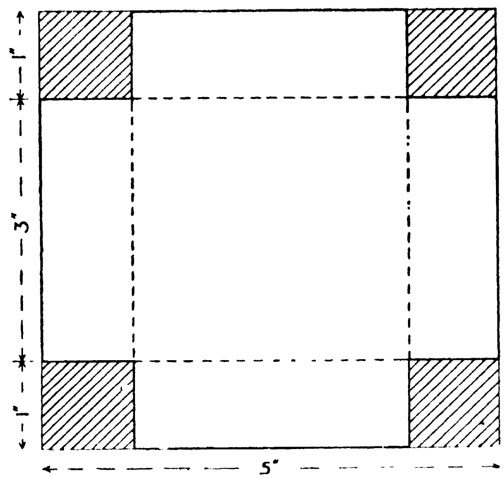
1. Bind external corners flush. In order to do this easily and effectively each child should be supplied with an inch cube or similar small rectangular solid. This is placed in the corner to be bound, and is of assistance in bringing the model to its true shape, and enables the child to press the binding firmly to the card.
2. Bind internal corners flush.
3. Bind upper edges, mitring both ends.
4. Bind lower edges, mitring as before.

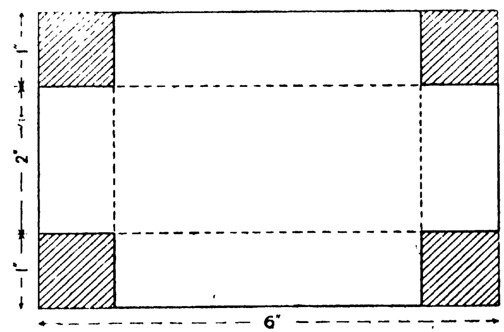
COVERING.

As in Model 14.

EXERCISES.

1. Find the volume of each of the models.
2. Find the volume of a rectangular cistern, $4\frac{1}{2}'' \times 3\frac{1}{2}'' \times 3''$.





20. Hanging Matchbox Holder

EXAMINATION AND CONSTRUCTION.

Let the pupils examine the completed model containing matchbox of the dimensions required.

The holder is an oblong prism with one side elongated.

Each boy should bring a matchbox and construct the model to the dimensions obtained by measuring his own box.

The model illustrated is taken from a box of tanstickhors.

Draw development; cut out waste, score and bend into shape.

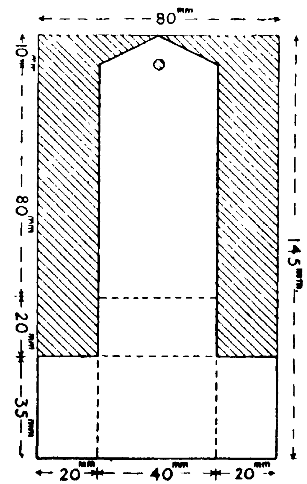
BINDING.

1. Bind edges to the back.
2. Bind opposite ends of the bottom.
3. Bind all other edges.

COVERING.

Cover all surfaces, remembering rules as to the lap of the covering over the binding.

The hole for hanging should be punched after the covering is completed.

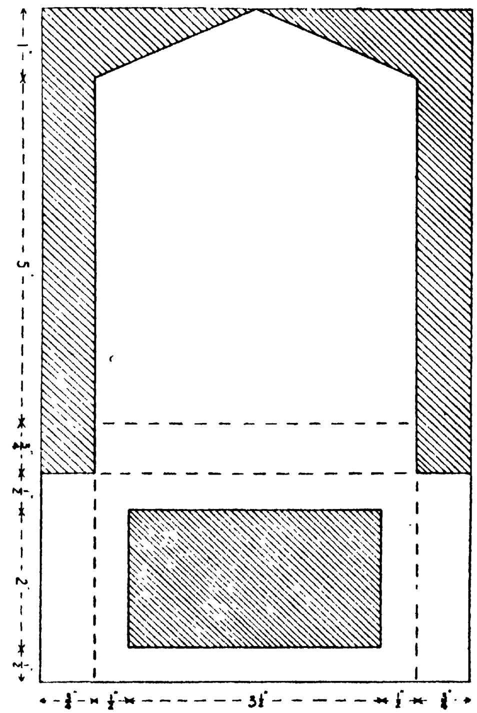


21. Perpetual Calendar

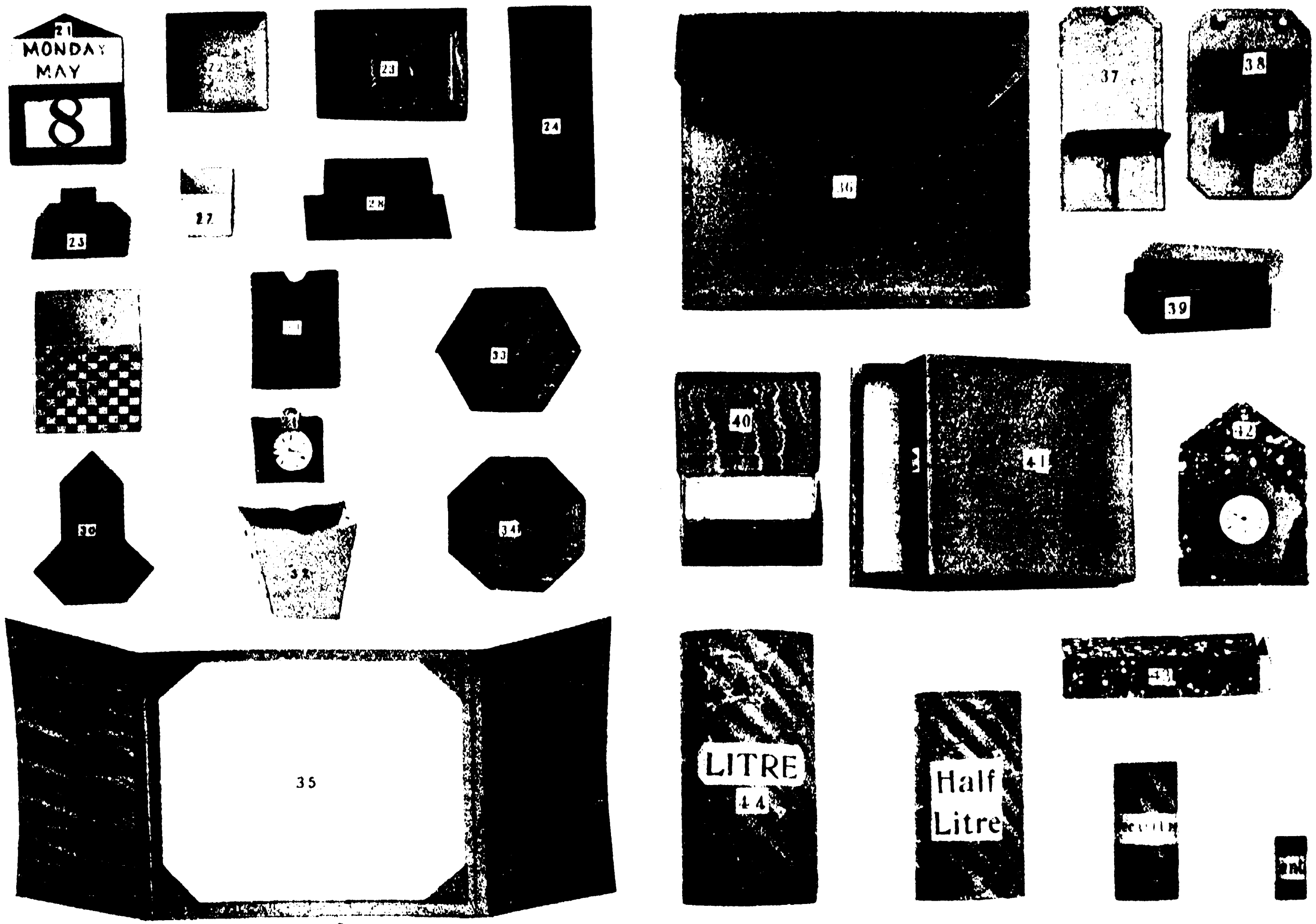
EXAMINATION AND CONSTRUCTION.

The method of construction of this model is similar to the last, differing only in dimensions, and having an opening in the front through which the figures are seen.

It should be made of stout cardboard, as it is in daily use.



MODELS FOR SENIOR COURSE.—II



21. Perpetual Calendar. 22. Square Tray. 23. Oblong Tray. 24. The Pen Tray. 25. Match Stand. 26. The Cube Decimetre. 27. The Cube. 28. Money Box. 29. Prayer-Book Case. 30. Triangular Tape Holder. 31. Watch Stand. 32. Plant Pot Cover. 33. Hexagonal Tray. 34. Octagonal Tray. 35. Folding Writing Case. 36. Portfolio with Flap. 37. Wall Bracket. 38. Hanging Match Bracket. 39. Box with Lid. 40. Hymn-book Case. 41. Handkerchief Box. 42. Pentagonal Watch Stand. 43. Sliding Pencil Box. 44. Metric Measures.

22. Square Tray

(Sloping Sides)

EXAMINATION AND CONSTRUCTION.

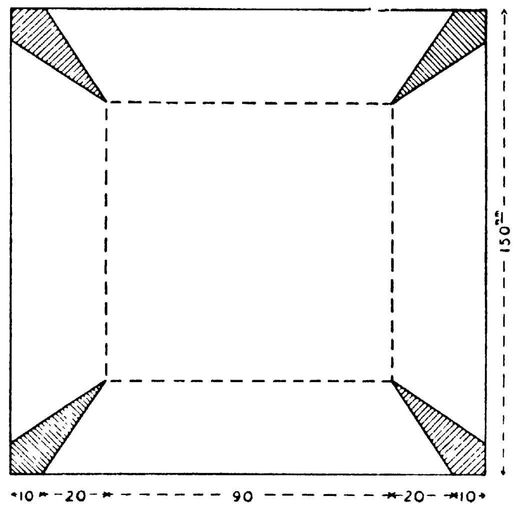
Examine the completed model to find the dimensions and method of construction. Draw the development and cut out the waste at the corners.

BINDING AND COVERING.

Proceed as in Model 16.

EXERCISES.

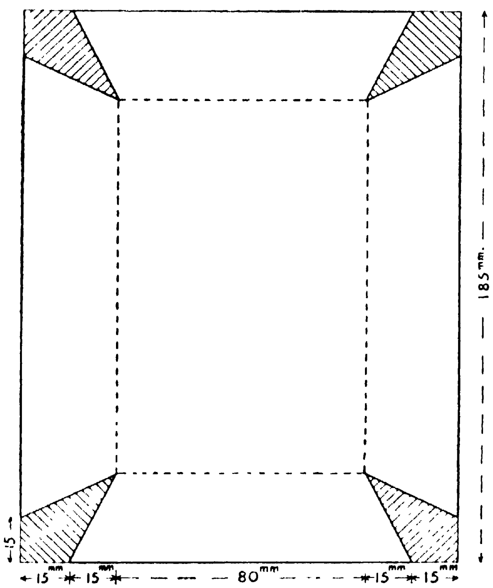
1. Find the area of the covering paper required for the inside of the tray.
2. If each long side is $a + 2b$ cm., and each short side $a - b$ cm., find the difference between the perimeters of the two squares.



23. Oblong Tray

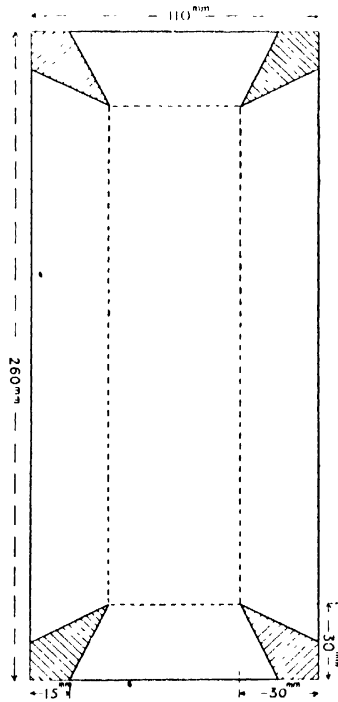
(With Sloping Sides)

Method as in last model.



24. The Pen Tray

This is a particular case of the Oblong Tray with sloping sides.



25. Match Stand

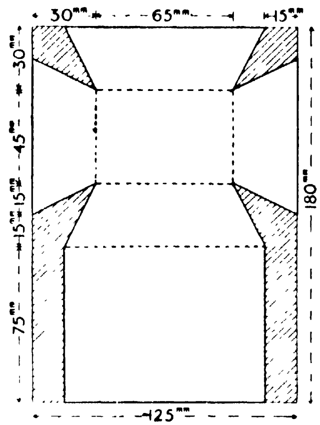
This is also a particular case of the Oblong Tray with sloping sides.

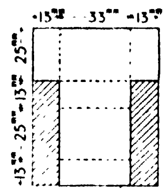
Construction as before, with the addition of a lid, which forms the base.

The dimensions for the matchbox block are taken from a box of tanstickhors. If any other brand be used the dimensions will vary accordingly.

In making the drawing an allowance is made of 2 mm. less in length and breadth to compensate for the thickness of the cardboard.

N.B.—In every case the *inside* measurement of the finished model corresponds to the measurements on the drawing. For instance, the dimensions of a tanstickhors case are 35 mm. × 15 mm. It will be observed from the drawing that the dimensions of the block are 33 mm. × 13 mm.





26. The Cubic Decimetre

EXAMINATION AND CONSTRUCTION.

Examine the completed model to find its dimensions and method of construction.

The model is constructed out of a square with a side measuring 300 mm.

Draw the development as indicated.

Cut out the waste and score along the dotted lines.

BINDING.

Bind the edges of the sides outside. A brick from a child's box or other rectangular solid of suitable dimensions may be used to give the necessary resistance applied to the binding.

Bind upper and lower edges.

COVERING.

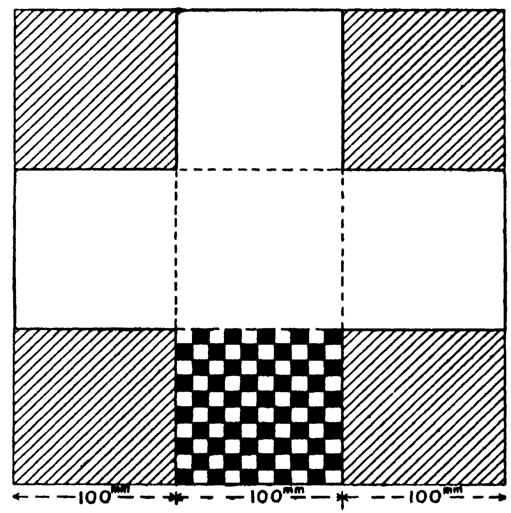
Cut out from sectional paper graduated in square centimetres a square decimetre.

Paste this on one of the sides; repeat for the other sides.

EXERCISES.

1. Calculate the volume in cubic centimetres.
2. Given a base of (8 × 8) centimetres, construct a box having a volume of 1000 cu. cm.
3. Given a base of (12 × 12) centimetres, construct a box having a volume of 1000 cu. cm.

Note.—Show the interdependence of the weights and measures of the metric system; unit of length from which is derived unit of area and unit of volume.



27. The Cube

EXAMINATION AND CONSTRUCTION.

The method of development is exactly as in last model, with the addition of a lid.

Measure, draw, and cut out.

BINDING AND COVERING.

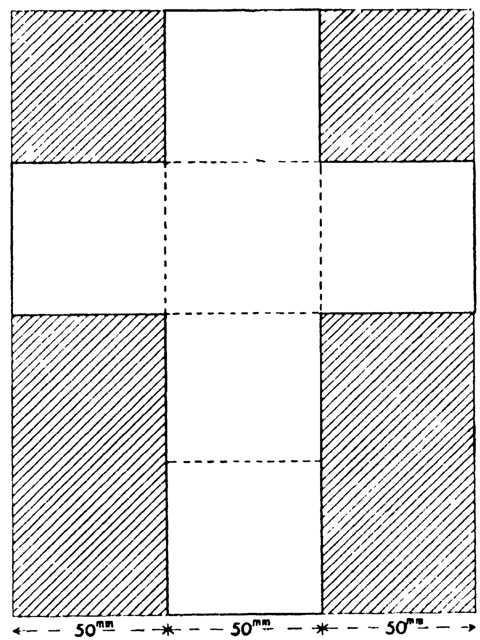
Bind the edges of the sides as in the last model.

Bind the lower edges. Fix and bind the top side.

Obtain the dimensions of the covering paper for each side, and construct a rectangle from which all six pieces may be cut, thus economizing both time and paper.

EXERCISE.

Find the volume; what fraction of a cubic decimetre is it?



28. Money Box

(On Base)

EXAMINATION AND CONSTRUCTION.

Proceed exactly as in the case of the cube.

The slot is exactly central. Given its dimensions and that of the oblong which contains it, the pupils should be required to locate its position by drawing two pairs of parallel lines.

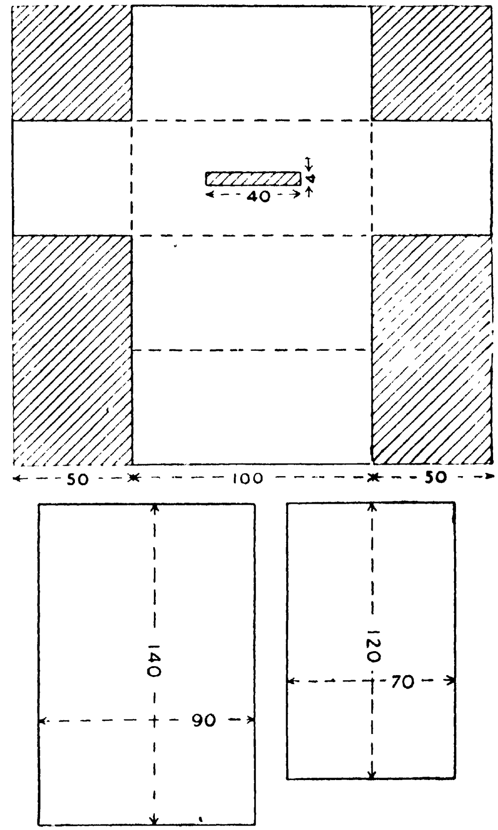
BINDING AND COVERING.

As in the Cube.

The Slot Side.—Place the covering paper for this side in position before pasting. Rub with the finger, and so mark the position of the slot.

Alternative Method.—Bind the edges of the slot before fixing the model together. The strips should be cut ½" longer than the sides of the slot to allow for the mitring at the corners.

The two pieces for the base should be covered on one side, fixed together, and allowed to dry under pressure before the box is pasted on.



29. Prayer-Book Case

(With Silk Cord Handles)

EXAMINATION AND CONSTRUCTION.

Each pupil should be required to bring a small Prayer Book or hymnbook.

Measurements should be taken and allowance made for fitting.

The model is simply an oblong prism open at one end, with thumb-holes.

The silk cord for the handles may be purchased at 1*d.* per yard, and should be of a colour which harmonizes with that of the covering paper.

BINDING AND COVERING.

Bind the edges of the sides.

Fix the bottom and bind all round.

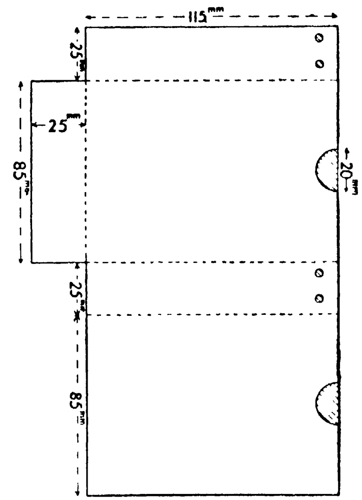
Bind upper edges, omitting thumb-hole.

Cover each side with leatherette cut to dimensions.

CUTTING THUMB-HOLE IN COVERING PAPER.

Lay the covering paper in position before pasting. Rub with the finger over the edges of the thumb-hole. Cut off the semicircle so marked.

The inside may be covered with marble paper to a depth of 5 or 6 cm.



30. The Triangular Taper Holder

EXAMINATION AND CONSTRUCTION.

Examine the completed model to discover its dimensions and construction.

Draw the development for the equilateral triangular prism.

Cut out; score and bend into position.

BINDING.

Bind the edges of the two meeting sides together; bind vertical edges flush and then fix the triangular base; bind the top edges, mitring outside and flush inside.

COVERING.

Find, by measuring, the size of the rectangle required to cover one side.

Construct a rectangle containing the three pieces required.

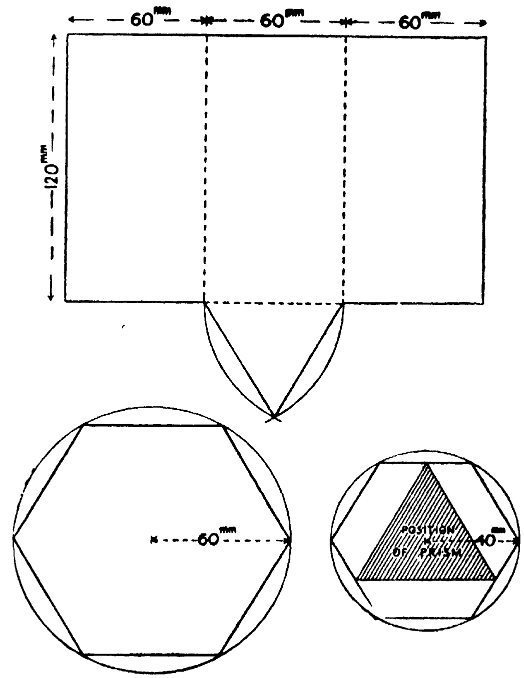
BASE.

Cut out two hexagons from stout cardboard to the dimensions given.

Bind the edges; cover and paste the small one centrally on the larger.

Fix the prism to the base as shown.

A weight, such as a book, should be placed on the top of the model until the paste sets.



31. Watch Stand

EXAMINATION AND CONSTRUCTION.

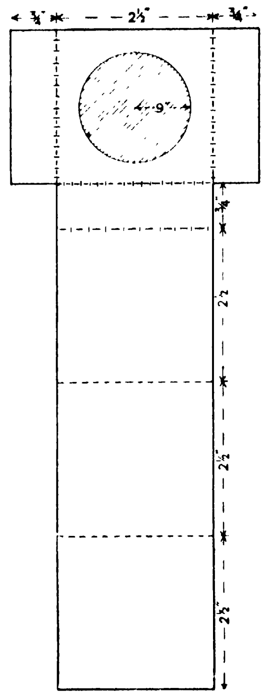
It will be observed that this model consists of a triangular prism lying on one of its sides, with a pocket attached to one of the other sides. Draw the development; score and cut out.

Note.—The four lines surrounding the pocket should be scored on the opposite side to the drawing. This is done by pricking through the ends of the lines with the compass needle.

BINDING AND COVERING.

Bind the prism as before. Fix the pocket as in illustration.

Cover each space so as to show ⅛" of binding at the edges.



32. Plant-pot Cover

EXAMINATION AND CONSTRUCTION.

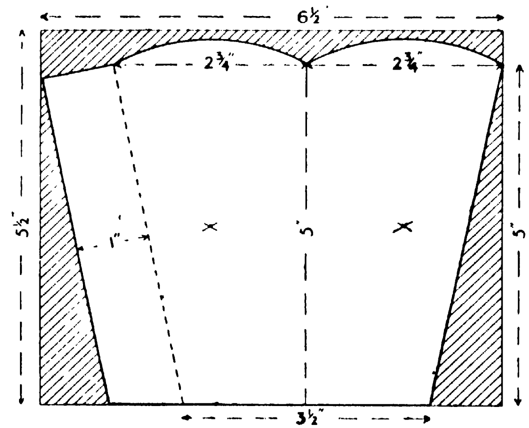
The pupils should be asked to bring a flower pot. They should be required to examine the completed model, which has been made for a 5″ pot. The dimensions of the pots should be found, and each child should construct a model to these dimensions.

There are two methods of procedure:—

1. Draw the development by geometrical methods, involving the copying of angles; or—
2. Proceed as indicated in diagram, making four pieces with a flap on one side and fastening together with paper fasteners.

EXERCISES.

1. Vary the shape of the top edge by a suitable design.
   e.g. Arcs of circles, curves, &c.
2. Ornament the sides with a suitable design in brush drawing.
3. Design and construct a stencil pattern to fill the spaces.



33. Hexagonal Tray

(Sloping Sides)

EXAMINATION AND CONSTRUCTION.

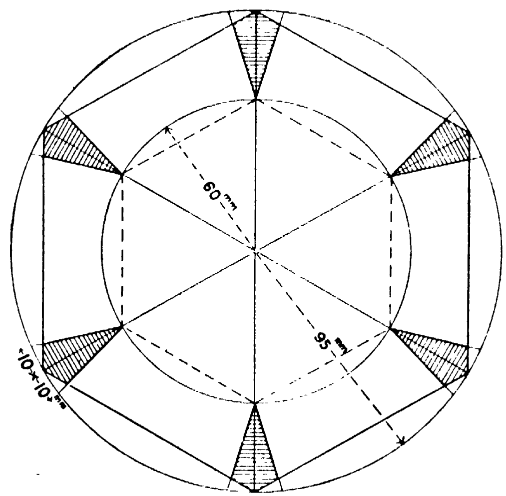
Examine completed model to find out the dimensions and method of construction.
Draw the development as indicated, and cut out.

BINDING.

1. Bind the edges together flush, internal and external.
2. Bind upper edges, mitring both ends.
3. Bind the lower edges, alternate sides first, flush at the bottom and mitred on the sides.
4. Bind the remaining three edges, mitring both ends.
5. Bind the remaining internal edges as in 3 and 4.

COVERING.

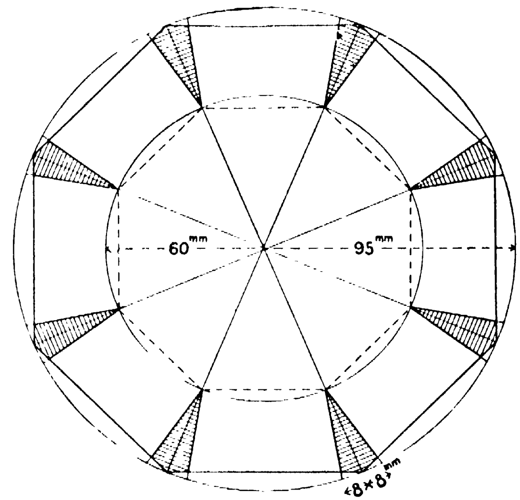
Find the dimensions for the covering paper for a side. Draw on the back of the covering paper, produce the parallel sides, and with the dividers mark off the long and short sides of the trapezoid alternately. Join the points; cut out and fix.
Repeat for lining paper.
Cut out and paste the hexagon for the bottom.



34. Octagonal Tray

(Sloping Sides)

Proceed as in last model.



35. Folding Writing Case

EXAMINATION AND CONSTRUCTION.

Examine the completed model.

It is composed of four pieces of cardboard—back, blotting pad, and two sides.

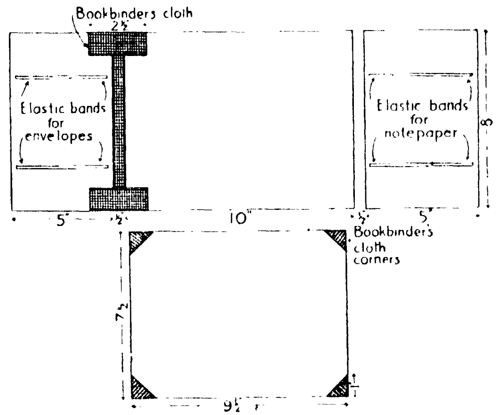
Draw and cut out the pieces required.

BINDING.

1. Bind upper and lower edges of the back.
2. Bind two short edges and one long one of the side pieces.
3. Bind all round the blotting-pad piece.
4. Cut out and fix the corner pieces of the blotting pad.

N.B.—This should be done with blotting paper on the pad, the corner pieces being fixed at the back only to allow the blotting paper to be replaced when required.

5. Cut out two pieces of bookbinder's cloth 10' × 2½", and fix the three pieces of cardboard together as shown in the diagram, and as in model No. 12.
6. Paste a piece of marble paper or leatherette (7½" × 2") inside.
7. Paste the back of blotting pad and fix.
8. Line the inside of side pieces with marble paper.
9. Fix elastic bands for notepaper and envelopes by drawing the ends through slits made for the purpose and glued at the back.
10. Cover the back with leatherette.



36. Portfolio with Flap

EXAMINATION AND CONSTRUCTION.

Examine the completed model to discover dimensions and method of construction.

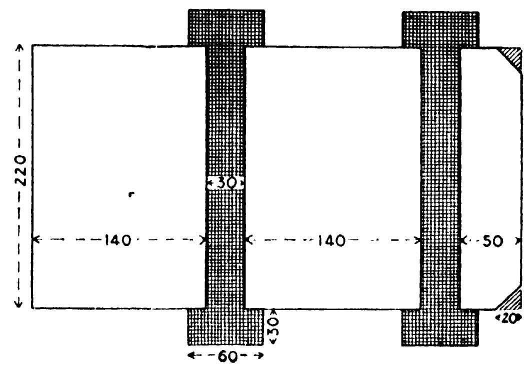
Cut out the three pieces.

Bind all edges not covered by bookbinder's cloth.

Fix together, using cloth as indicated in the diagram.

Cover the internal joins with lining paper (210 mm. × 60 mm.).

Cover the inside with marble paper and the outside with fancy paper or leatherette. The lining and covering paper should be of such dimensions as to leave a margin of 2 mm. round the edges of cardboard.



37. Wall Bracket

Stout cardboard will be required for this model.

EXAMINATION AND CONSTRUCTION.

Examine the completed model to discover dimensions and method of construction.

Draw and cut out the parts as indicated.

BINDING.

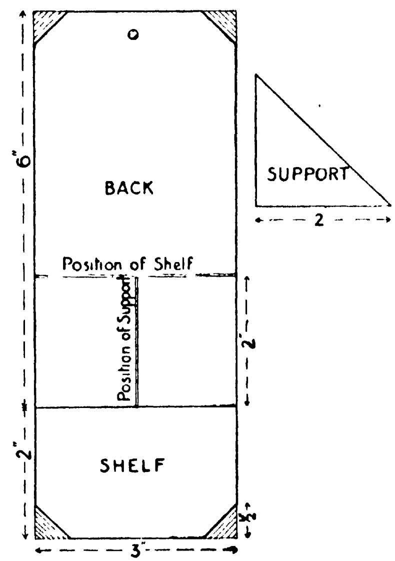
1. Bind the edges of the back piece all round.
2. Bind the front and side edges of the shelf.
3. Bind the hypotenuse of the triangular support.

FIXING THE SHELF.

1. Cut two pieces of beading 3″ long.
2. Fold along the centre with the gummed sides outwards.
3. Moisten one-half of each strip and fix one on each side of shelf. When dry, moisten the remaining portions of strips and fix to the back piece.
4. Fix the support in the same way.

COVERING.

Make drawing on the back of the covering paper of each space to be covered, allowing ⅛″ for margin in each case.



38. Hanging Match Bracket

(With Trough)

EXAMINATION AND CONSTRUCTION.

This model consists of four parts: (1) the back, (2) the trough, (3) the shelf, (4) the support.

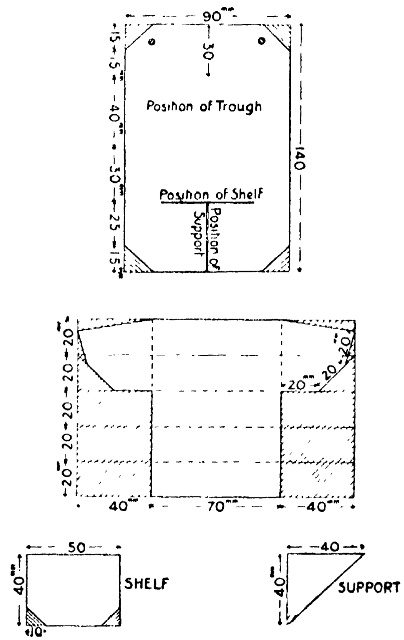
The back is a repetition of the exercise on the rectangular mat (Model 9). The shelf and support have been dealt with in the last exercise. The construction of the trough is clearly indicated in the diagram.

Several models of the trough fastened together by fix clips should be prepared previous to the lesson. From these the children will see the construction of the model, and should be required to draw the diagram from their own measurements.

Bind the edges of the back piece and cover both sides.

Bind, cover, and fix the shelf as in last exercise.

Bind, cover, line the inside with marble paper, and fix the trough in position with strong adhesive.



39. Box with Lid

EXAMINATION AND CONSTRUCTION.

The box should be completed first to the given dimensions.

The new exercise consists in finding the dimensions of the lid to fit the box.

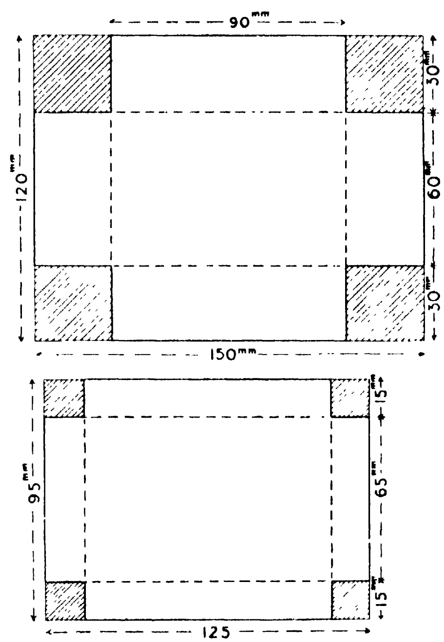
One method of arriving at the necessary allowance to be made is as follows.

Add to the dimensions of the box two thicknesses of cardboard, four thicknesses of binding, and four thicknesses of covering paper.

To find the thickness of cardboard, &c., count the number of pieces in a pile 1 cm. high, and so find the thickness of one piece.

A small allowance should be added for easy fitting.

In the model illustrated the allowance for lid is 5 mm. This model is covered with leatherette and lined with marble paper.



40. Hymnbook Case

(With Fall-down Front and Lid)

EXAMINATION AND CONSTRUCTION.

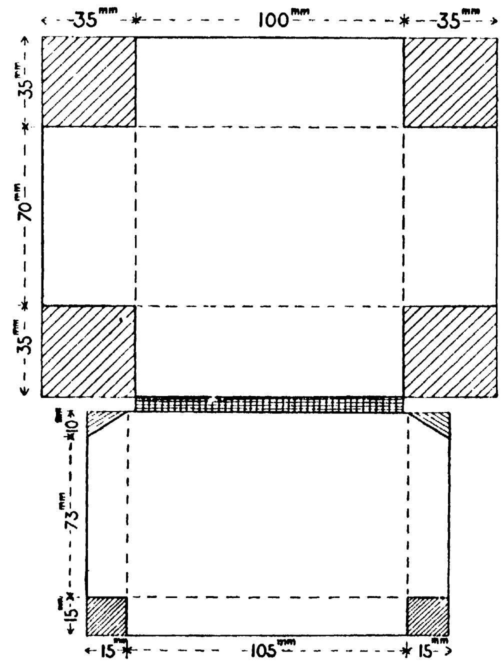
A completed model should be provided for inspection, and in this way the development and dimensions will be discovered.

It will be observed that there are two pieces joined together by a cloth hinge.

2 mm. is sufficient distance between the hinged parts.

1. Draw and cut out the parts of the model.
2. Fix together with bookbinder's cloth — note allowance of 2 mm. between the parts.
3. Fix sides of box and lid with binding strips.
4. Bind all edges.
5. Cover outside with leatherette and line with marble paper.

The dimensions of this model are based on a stock-sized book, but they may be altered to suit any book.



41. Handkerchief Box

This model and the preceding one are further examples of Model 39. Both are strengthened owing to their being placed on bases, which project ¼ in. beyond the sides of the boxes.

The edges of the base are bound.

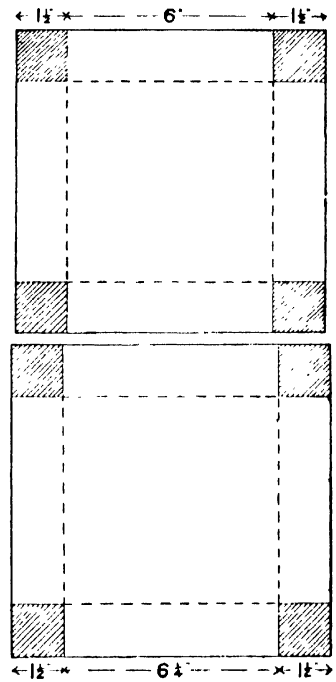
The under side is covered with marble paper.

In fastening the box to the base the model should be placed under a weight until the adhesive is set.

Good weights for this purpose may be made by covering bricks with brown paper.

EXERCISE.

Construct a glove box on the same principle as the above. Measure an ordinary glove to find dimensions.



42. Pentagonal Watch Stand

EXAMINATION AND CONSTRUCTION.

Examine a completed model to discover dimensions and method of construction.

THE BACK.

1. Cut out of stout cardboard to the given dimensions.
2. Bind the edges. Cover front with leatherette and the back with marble paper.

THE POCKET.

This is formed of a pentagonal prism having two sides omitted. The circular opening may vary with the size of the watch face. The method of constructing the pentagon is left to the discretion of the teacher.

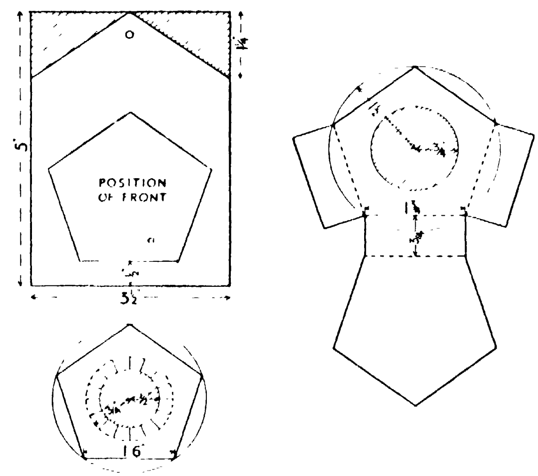
The protractor may be used to obtain the angle at the base (108°), or a circle having a radius of 1½″ may be described and lines drawn from the centre at an angle of $360° \div 5 = 72°$.

The best instrument for cutting out the circular opening is a sharp-pointed penknife.

Bind all edges. Cover the front and sides with suitable paper or leatherette. See diagram for the front covering.

Two circles with radii 1½″ and ¾″ respectively are drawn. Cut out the smaller circle and mark a number of cuts in the remaining ¼-in. ring. Paste on the front and bend back the flanges.

Use a strong adhesive to fix the pocket to the back.



43. Sliding Pencil Box

EXAMINATION AND CONSTRUCTION.

Examine the completed model to ascertain dimensions.

Note that the standard length of a lead pencil is 7 in.

The box should be constructed first, and calculations made for the amount of allowance necessary in the size of the cover.

In this case ⅛″ has been found to be sufficient.

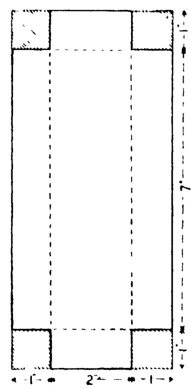
The cover is ¼″ longer than the box; so that the ends do not project. This renders the box dustproof.

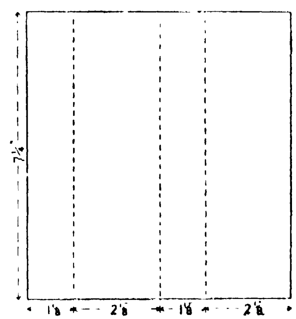
THE BOX.

Bind all edges and cover inside and out with marble paper.

THE CASE.

Bind all edges. Cover each face separately or cut a piece of leatherette of a sufficient size to cover the whole case, allowing ½″ at each end for turning in and ½″ for overlapping.





MEASURES

44. Metric Measures

The object of the following exercises is to give the pupil an intimate knowledge of the sizes of the various measures in common use.

The metric measures are taken first as being more scientific, and, their volumes being accurately known, we may work out developments to any convenient proportions.

The Litre

This measure contains 1000 cu. cm. The first step is to adopt a convenient diameter for the base. In all cases we have adopted an even multiple of 7, as this gives the results of πr^2 as a terminating decimal.

$$\text{Let diameter of base} = 9\cdot 8 \text{ cm.}$$
$$\text{Area of base} = \pi r^2$$
$$= \left(\frac{22 \times 4\cdot 9 \times 4\cdot 9}{7}\right) \text{ sq. cm.}$$
$$= 75\cdot 46 \text{ sq. cm.}$$
$$h = \frac{1000}{75\cdot 46} \text{ cm.}$$
$$= 13\cdot 252 + \text{ cm.}$$

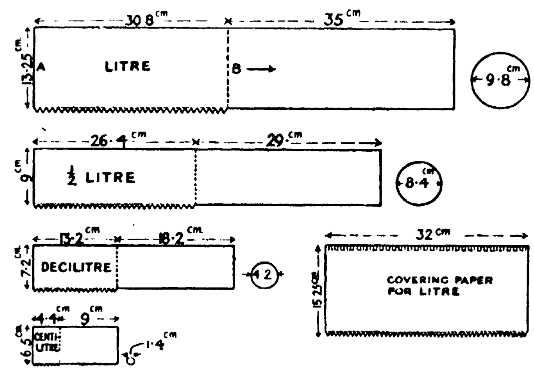
From these figures

$$v = (75\cdot 46 \times 13\cdot 252 +) \text{ cu. cm.}$$
$$= 999\cdot 99 + \text{ cu. cm.}$$

As π is only an approximation it is impossible to get an exact result, but the pupils will readily see that $\cdot 9$ is a recurring decimal and equals 1.

$$\text{Circumference of the base} = 2\pi r$$
$$= \frac{2 \times 22 \times 4\cdot 9}{7}$$
$$= 30\cdot 8 \text{ cm.}$$

This gives the whole data for the construction of the cylinder.



CONSTRUCTION.

Draw and cut out a diagram for the litre, as indicated, in thin card or stout cartridge paper. Cut three circles, radius 4·9 cm.

Well paste that part of the development without the toothed flange. Place the edge marked A to coincide with the line marked B, and roll the pasted portion carefully round the cylinder, taking care that the edges coincide.

Place a round ruler through the cylinder and roll on the desk in the direction indicated by the arrow

from B. It is best to protect the desk with a piece of brown paper, as the roller will squeeze out superfluous paste.

To strengthen the model it is best to provide it with a double bottom. Place one of the circles inside and one outside. The toothed flange will then be enclosed between the two circles. The third circle is placed temporarily in the mouth of the cylinder to preserve its true shape while drying.

COVERING.

Cut a piece of marble paper to the dimensions given, and draw lines parallel to the upper and lower edges at a distance of 1 cm. from them. The lower edge is toothed for turning under, while the other edge is cut at intervals of 5 mm. as shown. This is necessary, as the internal circumference is less than the external.

The circle for the bottom should have a radius of 4·7 cm.

The methods of construction and procedure are precisely the same in all these models, therefore the figures and methods of arriving at them only are given.

Half-litre = 500 cu. cm.

Let diameter of base = 8·4 cm.

Area of base = πr^2

$$= \left(\frac{22 \times 4{\cdot}2 \times 4{\cdot}2}{7}\right) \text{ sq. cm.}$$

$$= 55{\cdot}44 \text{ sq. cm.}$$

$$h = \frac{v}{\pi r^2}$$

$$= \frac{500}{55{\cdot}44} \text{ cm.}$$

$$= 9{\cdot}018 + \text{ cm.}$$

From these figures –

$$v = (55{\cdot}44 \times 9{\cdot}018 +) \text{ cu. cm.}$$

$$= 499{\cdot}9 + \text{ cu. cm.}$$

$$c = 2\pi r$$

$$= \left(\frac{2 \times 22 \times 4{\cdot}2}{7}\right) \text{ cm.}$$

$$= 26{\cdot}4 \text{ cm.}$$

Decilitre = 100 cu. cm.

Let diameter of base = 4·2 cm.

Area of base = πr^2

$$= \left(\frac{22 \times 2{\cdot}1 \times 2{\cdot}1}{7}\right) \text{ sq. cm.}$$

$$= 13{\cdot}86 \text{ sq. cm.}$$

$$h = \frac{v}{\pi r^2}$$

$$= \frac{100}{13{\cdot}86} \text{ cm.}$$

$$= 7{\cdot}215 + \text{ cm.}$$

$$v = (7{\cdot}215 + \times 13{\cdot}86) \text{ cu. cm.}$$

$$= 99{\cdot}9999 +$$

$$c = 2\pi r$$

$$= \left(\frac{2 \times 22 \times 2{\cdot}1}{7}\right) \text{ cm.}$$

$$= 13{\cdot}2 \text{ cm.}$$

Centilitre = 10 cu. cm.

Let diameter of base = 1·4 cm.

Area of base = πr^2

$$= \left(\frac{22 \times {\cdot}7 \times {\cdot}7}{7}\right) \text{ sq. cm.}$$

$$= 1{\cdot}54 \text{ sq. cm.}$$

$$h = \frac{v}{\pi r^2}$$
$$= \frac{10}{1 \cdot 54}$$
$$= 6 \cdot 49 \text{ cm.}$$
$$v = \pi r^2 \times h$$
$$= (1 \cdot 54 \times 6 \cdot 49) \text{ cu. cm.}$$
$$= 9 \cdot 99 \text{ cu. cm.}$$
$$c = 2\pi r$$
$$= \frac{2 \times 22 \times \cdot 7}{7} \text{ cm.}$$
$$= 4 \cdot 4 \text{ cm.}$$

---

45. English Measures

Quart

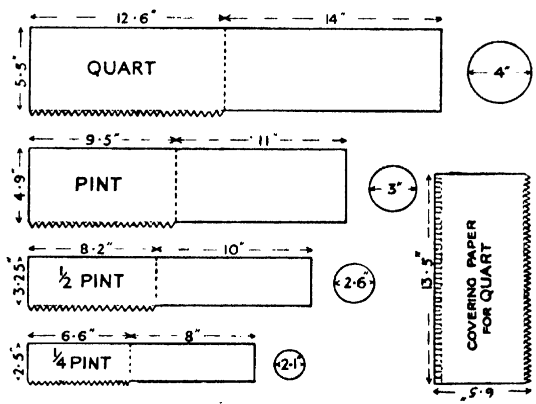
Let diameter of base $= 4''$; $v = 69 \cdot 3185$ cu. in.

Area of base $= \pi r^2$
$$= \left(\frac{22 \times 2 \times 2}{7}\right) \text{ sq. in.}$$
$$= 12 \cdot 57 \text{ sq. in.}$$
$$h = \frac{69 \cdot 3185}{12 \cdot 56} \text{ in.}$$
$$= 5 \cdot 56 \text{ in. (approx.)}$$
$$c = 2\pi r$$
$$= \left(\frac{2 \times 22 \times 2}{7}\right) \text{ in.}$$
$$= 12 \cdot 57 \text{ in.}$$

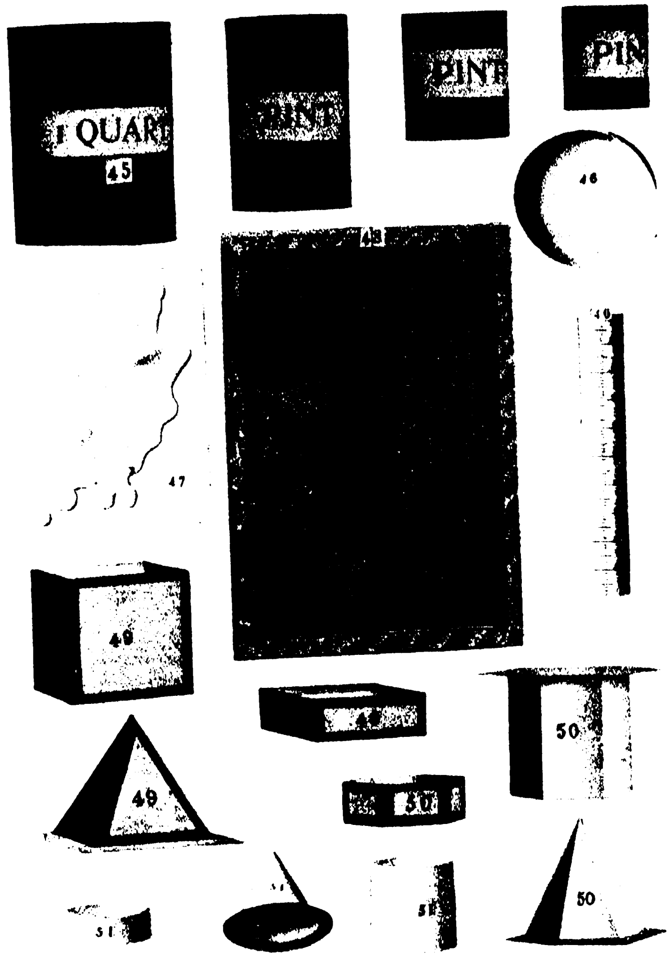
Pint

Let diameter of base $= 3''$; $v = 34 \cdot 65925$.

Area of base $= \pi r^2$
$$= \frac{22 \times 1 \cdot 5 \times 1 \cdot 5}{7} \text{ sq. in.}$$
$$= 7 \cdot 07 \text{ sq. in. (approx.)}$$
$$h = \frac{34 \cdot 65925}{7 \cdot 07} \text{ in.}$$
$$= 4 \cdot 9 \text{ in.}$$
$$c = 2\pi r$$
$$= \left(\frac{2 \times 22 \times 1 \cdot 5}{7}\right) \text{ in.}$$
$$= 9 \cdot 5 \text{ in.}$$



MODELS FOR SENIOR COURSE—III



45. English Measures. 46. Rain Gauge and Measure. 47. Contour Map of Isle of Man. 48. Contour Map of Portion of Avon Valley. 49. The Cube and Square Pyramid. 50. Hexagonal Prism and Pyramid. 51. The Cylinder and Cone.

Half-pint

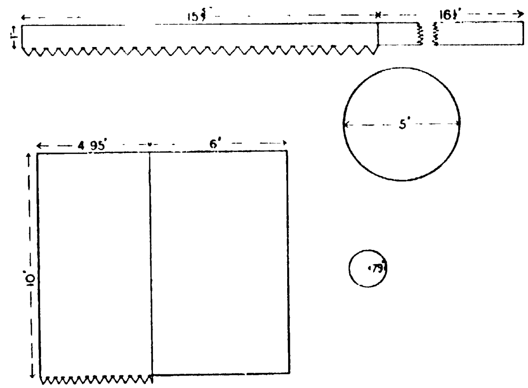
$$
\begin{aligned}
\text{Let diameter of base} &= 2\cdot6''; \; v = 17\cdot329625 \text{ cu. in} \\
\text{Area of base} &= \pi r^2 \\
&= \left(\frac{22 \times 1\cdot3 \times 1\cdot3}{7}\right) \text{ sq. in.} \\
&= 5\cdot31 \text{ sq. in.} \\
h &= \frac{17\cdot329625}{5\cdot31} \text{ in.} \\
&= 3\cdot26 \text{ in.} \\
c &= 2\pi r \\
&= \left(\frac{2 \times 22 \times 1\cdot3}{7}\right) \text{ in.} \\
&= 8\cdot17 \text{ in.}
\end{aligned}
$$

Quarter-pint

$$
\begin{aligned}
\text{Let diameter of base} &= 2\cdot1''; \; v = 8\cdot6648 \text{ in.} \\
\text{Area of base} &= \pi r^2 \\
&= \left(\frac{22 \times 1\cdot05 \times \overset{\cdot15}{\cancel{1\cdot05}}}{\cancel{7}}\right) \text{ sq. in.} \\
&= 3\cdot48 \text{ sq. in.} \\
h &= \frac{8\cdot6648}{3\cdot48} \text{ in.} \\
&= 2\cdot5 \text{ in. (approx.)} \\
c &= 2\pi r \\
&= \left(\frac{2 \times 22 \times \overset{\cdot15}{\cancel{1\cdot05}}}{\cancel{7}}\right) \text{ in} \\
&= 6\cdot6 \text{ in.}
\end{aligned}
$$

46. The Rain Gauge and Measure

In schools where weather observations and records are made, some difficulty is experienced in getting the pupils to understand the principle of the measuring glass used with the rain gauge. The construction of the two following models will render this quite clear.



Use silver sand in the experiments in testing the accuracy of the models.

RECEIVING CYLINDER.

Construct a cylinder, from thin cardboard or stout cartridge paper, 5″ in diameter and 1″ in height.

Find the volume of this cylinder, and from the data thus obtained construct a cylinder of equal volume having a height of 10 in.

A height of 10 in. is chosen for convenience. The scale on the measuring cylinder consists of 10 in. divided into tenths. This can be transferred directly from the ruler on to a strip of paper, which should then be pasted to the side of the cylinder.

The height on the receiving cylinder is magnified ten times, thus permitting easy reading to ·005 of an inch.

EXERCISES.

1. Fill measuring glass with silver sand; pour into the receiving cylinder. If the models are accurately made the volumes should coincide, therefore 1″ of rain in the rain gauge coincides with the full scale on the measuring glass.
2. Half-fill the measuring glass. Read the scale which records ·50 in. Pour into the receiving cylinder, which will now be half-full, the depth measuring exactly half an inch.
3. Proceed similarly for other measurements.
4. Dictate various depths of rain, e.g. ·35, ·73, ·29, &c. Let each pupil indicate these heights on his model. This gives practice in reading the scale.
5. Given that 1 cu. ft. of water weighs $62\frac{1}{2}$ lb., calculate the amount of rainfall over certain known areas.
   e.g. The playground, school garden, individual plots in garden, one acre, &c.
6. Observe the amount of rainfall necessary to cause floods in the home district.

The figures for these exercises are as follows:—

$$
\begin{aligned}
\text{Given diameter of cylinder} &= 5 \text{ n.} \\
\text{Radius} &= 2{\cdot}5 \text{ in.} \\
\text{Circumference} &= 2\pi r \\
&= (2 \times \tfrac{22}{7} \times \tfrac{5}{2}) \text{ in.} \\
&= \frac{110}{7} \\
&= 15\tfrac{5}{7} \text{ in.} \\
v &= \pi r^2 h \\
&= (\tfrac{22}{7} \times \tfrac{5}{2} \times \tfrac{5}{2} \times 1) \text{ cu. in.} \\
&= \frac{275}{14} \text{ cu. in.} \\
&= 19{\cdot}64 \text{ cu. in.}
\end{aligned}
$$

MEASURING CYLINDER.

$$
\begin{aligned}
\text{Given volume} &= 19{\cdot}64 \text{ cu. in.} \\
\text{Height} &= 10 \text{ in.} \\
\therefore \text{area of base } \pi r^2 &= \frac{v}{h} \\
&= \left(\frac{275}{14 \times 10}\right) \text{ sq. in.} \\
&= \frac{27{\cdot}5}{14} \text{ sq. in.} \\
\therefore r^2 &= \frac{27{\cdot}5 \times 7}{14 \times 22} \text{ sq. in} \\
&= \frac{2{\cdot}5}{4} \text{ sq. in.} \\
\therefore r &= \sqrt{\frac{2{\cdot}5}{4}} \text{ in.} \\
&= \sqrt{\frac{25}{40}} \text{ in.} \\
&= \frac{5}{6{\cdot}32} \text{ in.} \\
&= {\cdot}79 \text{ in.; or} \\
& {\cdot}8 \text{ in. (approx.)}
\end{aligned}
$$

ADVANCED PAPER MODELLING

1. Norman Arch. 3. A Font. 2. Pointed Gothic Arch.

Facing p. 183

ADVANCED PAPER MODELLING

The object of this exercise is to show how apparently complicated models may be built up by a combination of simple elements. In this connection one should not attempt to construct a whole model in one piece, but should rather analyse it and build up from its simple elements.

The illustration (see plate) shows three models made of stout cartridge paper.

1. NORMAN ARCH.

This model is made up of—

(*a*) The cube.

(*b*) The cylinder.

(*c*) The circle scored and bent to form ornamental capital.

(*d*) The oblong prism with semicircular portions removed.

2. POINTED GOTHIC ARCH.

(*a*) The cube.

(*b*) The octagonal prism.

(*c*) The frustum of an octagonal pyramid inverted.

(*d*) Oblong prism with portions removed.

(*e*) The oblong prism forming an abutting wall.

(*f*) The oblong prism in combination with a triangular prism to form the buttress.

3. A FONT.

(*a*) *Base.*—Two steps formed of square prisms.

(*b*) *Column.*—Seven cylinders, six of which are tangential to each other and the central cylinder.

(*c*) *Capital.*—Circle scored and bent as in No. 1.

(*d*) *Basin.*—Hexagonal tray with sloping sides.

The construction of these models will form combined classwork. This section is merely suggestive of the method to be adopted in the construction of any model illustrative of examples for lessons in such subjects as geography, history, &c.

MAP MAKING

47. Contour Map and Model of Isle of Man

The following is an outline of the method used in teaching a branch of map reading.

It is an advantage to choose an island for a first exercise. The Isle of Man, consisting as it does of two mountain masses with an intervening valley, provides an exercise which is within the capacity of children of ten years of age.

METHOD.

1. Provide each child with a contour map as shown in the illustration, and let him colour it, using the following scale:—

Sea, light blue.
0 to 250 ft., sap green.
250 to 500 ft., yellow ochre.
500 to 1000 ft., brown madder.
1000 to 2000 ft., vandyke brown.

Note.—A definite scale of colouring should be used throughout the school, so that the same colour always indicates the

same elevation. As a rule only three elevations need be shown on the maps used in primary schools, i.e. lowlands, 0 to 600 ft.; uplands, 600 to 1200 ft.; highlands over 1200 ft. A useful scale is lowlands, sap green; uplands, brown madder; highlands, vandyke brown.

These colours should be kept ready mixed, so that a constant shade is always available.

2. Supply each child with a blank contour map, a piece of carbon tracing paper, and a sheet of thick cardboard. He should be required to trace the portion bounded by the 250-ft. contour line, marking the position of the next height on the same piece. Cut along the 250-ft. contour line thus traced and lay aside.

Similarly trace the portion bounded by the 500-ft. contour line, marking the position of the next height as before.

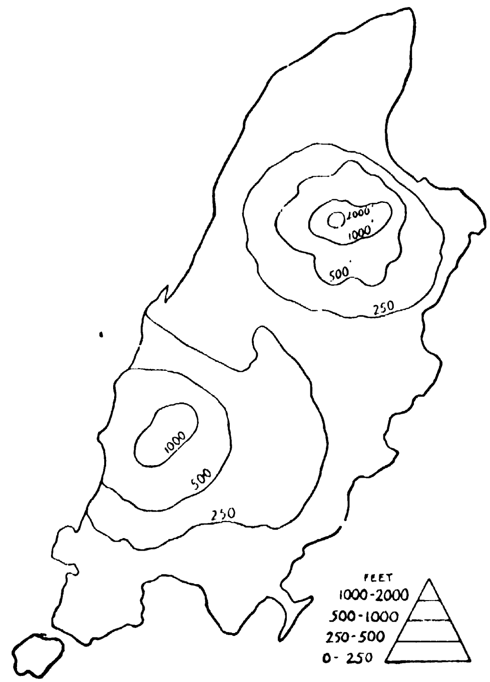
Proceed similarly until all the pieces are cut out.

Glue the 250-ft. portions to the map, and when dry add the other pieces in order. Note that two thicknesses will be required of the 500 ft. to 1000 ft., and four thicknesses for the 1000 ft. to 2000 ft., as each thickness represents a height of 250 ft.

3. Commencing at the top, cover the whole map with plasticine, following the slopes made by the cardboard. It is well to place a thin roll of plasticine round the outline of the map, pressing it very thinly on the coast line and gradually increasing in thickness to the first height.

4. A permanent record of the work can be made by selecting the best model to be cast in plaster of Paris as follows.

Surround the model by a wall, which may be of wood, strips of zinc, or glass.



Seal the bottom edges and corners with plasticine. Brush over the model with vaseline. Calculate the number of cubic inches contained in the frame, deducting roughly the cubical contents of the model. Calculate the amount of water required, given that 1 pt. equals 34·6 cu. in. Have ready in a basin the required amount of water. Add the plaster of Paris gradually, stirring all the time until the mixture is of the consistency of cream.

Pour the plaster on the model and leave to set for an hour. This forms the negative.

Surround the negative with the strips as before. Seal any openings which appear between the negative and the strips with plasticine.

Well brush the whole of the negative with salad oil. Mix the plaster as before; pour it in and leave till set. If the oiling has been carefully and thoroughly done the model should come away quite easily.

A NATURE RAMBLE

48. Contour Map and Model of Portion of Avon Valley

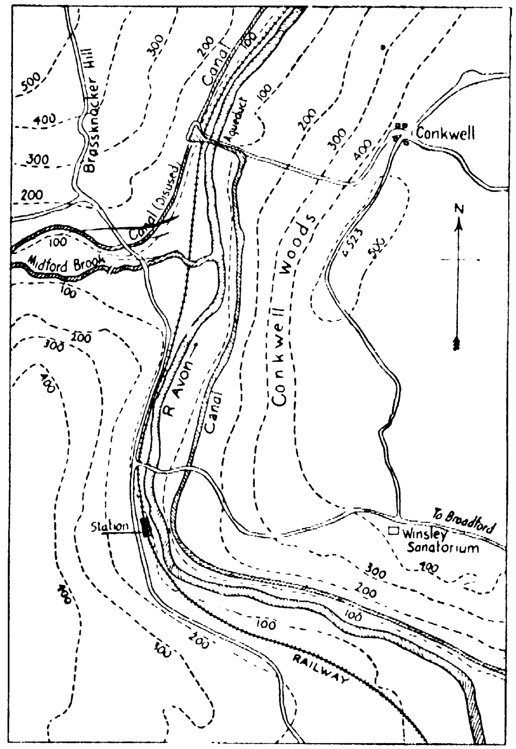
OBJECTS.

1. To study a river valley, and—
2. To collect specimens of the flora found in a limestone district.

METHOD.

The following describes an actual ramble.

The district selected was a portion of the Avon valley, measuring 2 miles by 1¼ miles.



From a 6-in. ordnance survey map a tracing was taken of the area to be studied. The features selected, as will be seen by the map, were (1) river, (2) roads, (3) canal, (4) railway, (5) contour lines for every 100 ft. of height.

A large number of copies of this map were reproduced by means of a cyclostyle. These copies were coloured by the children to show the heights as expressed by the contour lines, the scheme of colouring adopted being that used by the children in all their orographical maps. Each boy was now required to produce a model of the map in cardboard, the ordinary medium card used in handwork lessons being utilized.

By means of carbon paper each contour line was transferred to the cardboard, cut out, and pasted in position.

By calculation the cardboard should have been $\frac{1}{3}$ in. thick to show exact vertical scale. As this is too thick for children to manipulate, it is necessary to use a sufficient number of thicknesses of thin cardboard to give the correct vertical scale. The steps can be filled in with clay, plasticine, or any plastic medium available.

The construction of this map and model, taken in conjunction with the actual fieldwork, gives the child a conception of map making and map reading otherwise unobtainable.

A FEW POINTS NOTED.

The canal follows the 100-ft. contour line throughout the whole length surveyed, therefore there is a notable absence of locks. At the north end of the valley the nature of the ground makes it expedient for the canal to be transferred to the other side of the valley. This is done by means of an aqueduct, which crosses over the river and the railway. The river flows along the lowest point of the valley, the ground sloping towards it from both sides. A tributary enters the river on the left from a secondary valley, down which the same features are reproduced.

The railway runs approximately parallel to the river, showing evidences of scientific construction. The engineers have chosen the way of least resistance, to save expense.

The roads are a contrast to the railway in some ways. They lead over hills much too steep for an ordinary railway, and many useful lessons can be deduced by the historical comparison between roads and railways.

From the highest point on the right of the valley the child has a bird's-eye view of the country which he has mapped, and learns, among many other things, that where the contour lines are close together the hills have a steep slope, and where the contour lines are wide apart the slope is gentle.

The flora naturally varies with the season, but on this particular date (31st May) over a hundred specimens were found, including half a dozen rare members of the orchis family. Each boy carried a home-made vasculum to contain and preserve his specimens. This consisted of an ordinary 7-lb. air-tight cylindrical tin slung over his shoulder by means of a stout cord or strap, which was attached to the tin by means of screw eyes screwed into small blocks of wood inside the tin.

MODELS TO SHOW THE RELATION BETWEEN THE VOLUMES OF PRISMS AND PYRAMIDS

1. The cube and square pyramid.
2. The hexagonal prism and hexagonal pyramid.
3. The cylinder and cone.

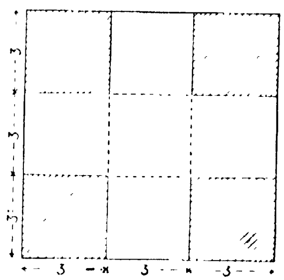
49. The Cube and Square Pyramid

The method of constructing the hollow cube calls for no comment. The diagram clearly shows the method of obtaining the "slant height" of the pyramid, and also the development of the same. Half-inch flaps are left at the base of the pyramid for the purpose of gluing to the stiffener as shown in the illustration. This gives rigidity to the pyramid.

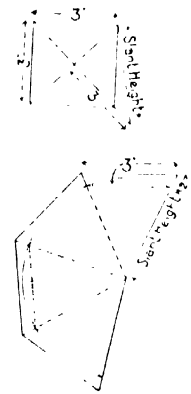
The square tray illustrated forms a "common" measure of the cube and pyramid.

These models illustrate the general rule that a square pyramid having an equal base and height to a square prism will be one-third of its volume.

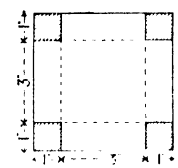
The volume of the tray is obviously one-third the volume of the cube. If filled with silver sand it will contain sufficient to completely fill the pyramid.



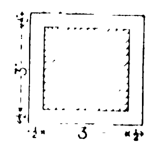
Development of Cube



Development of Pyramid



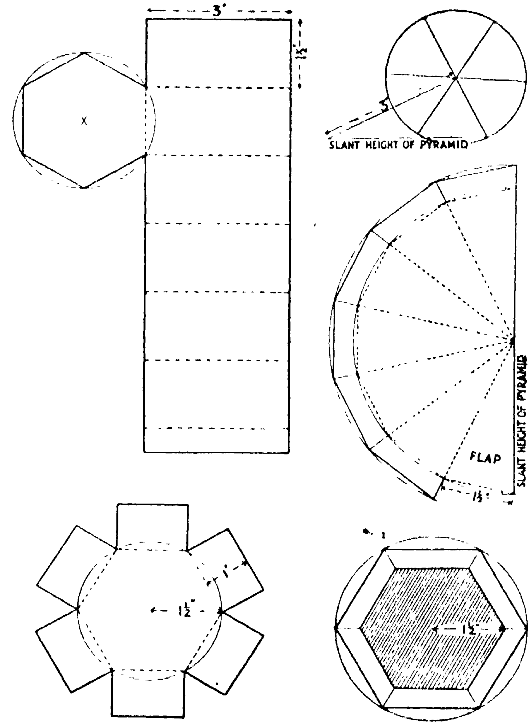
Square Tray



Stiffener

50. The Hexagonal Prism and Pyramid

This is simply a further illustration of the principle stated above.



51. The Cylinder and Cone

The method of constructing the cylinder has already been fully dealt with. The method of obtaining the development for the side of the cone is interesting. Obtain the "slant height" by the method shown. This will be found to be $3\frac{3}{8}''$ long. With this radius construct a circle. Mark off an arc of 160°. This is obtained as follows. It is required to mark off on this circle an arc equal to the circumference of the

Base of the cylinder $= 6\frac{3}{4}''$
Diameter of large circle $= 6\frac{3}{4}''$ by measurement.
Circumference ,, $= \pi d$

$$= \left(\frac{\cancel{22}^{\,11}}{7} \times \frac{27}{\cancel{4}_{\,2}}\right) \text{ in.}$$

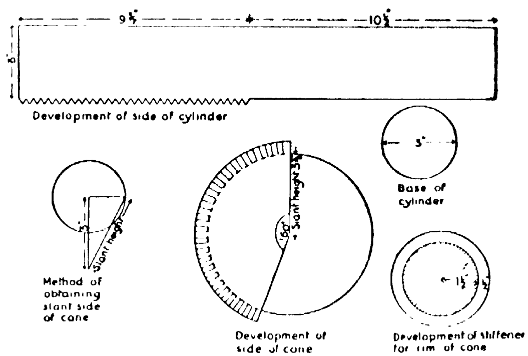
$$= \frac{297}{14} \text{ in.}$$

$$= 21\tfrac{3}{14} \text{ in.}$$

$$1^\circ \text{ of arc subtends } \left(\frac{297}{14} \times \frac{1}{360}\right) = \frac{33}{560} \text{ in.}$$

$\frac{33}{560}$ in. is subtended by 1°.
$\frac{66}{7}$ in. ,, ,, x°.

$$\therefore x^\circ = \left(\frac{\cancel{66}^{\,2}}{\cancel{7}} \times \frac{\cancel{560}^{\,80}}{\cancel{33}_{\,1}}\right)^\circ = 160^\circ.$$



Communal Work

J. L. MARTIN
AND
C. V. MANLEY

COMMUNAL WORK

One of the best ways of creating and sustaining interest, of stimulating direct observation and developing initiative, is by the adoption of a "centre of interest". The building up of a composite model may be the work of one class, or the whole school. In the latter case the models are graded in difficulty of construction and material to suit the varying powers of the pupils. The following are suggested centres of interest which have been actually worked out by the boys in an elementary school.

I. POULTRY YARD.

Scale 1″ to 1′, erected on a board 48″ by 36″.

Railings.—Paper—Standard II.

Posts.—Paper—Standard V.

Gates.—Five-barred gate, double gate, wicket gate, stile. Cardboard—Standard IV.

Hencoops.—Observation and measurement of actual specimens. Cardboard models—Standard V.

Feeding Troughs.—Paper model—Standard I.

Pump and Trough.—Paper model—Standard VI.

Drinking Fountain.—Plasticine model from actual stoneware specimen—Standards I and II.

Pigeon House.—Paper model—Standard VI.

Poultry House.—Cardboard model—Standard IV.

Modelling of Poultry in Plasticine. Cocks, hens, and chickens, ducks, geese, turkeys, &c.—All classes.

II. A GARDEN.

Scale ⅛ full size, 1½″ to 1′.

Walls.—Paper models. Lessons on brickwork. Actual building with bricks illustrating various bonds. Walls—in Old English bond—paper. Piers—in Flemish bond—paper—Standard VI.

Gates.—Double doors—small door. Wicket gate. Strip wood or stout card—Standard V.

Greenhouse.—Lean-to model in paper or thin card—Standard V.

Summer House.—Pagoda pattern—paper—Standard IV.

Garden Seats.—Light wood—cardboard or paper—All classes.

Garden Roller.—Paper cylinder—wire spindle—wooden handles—Standard VI.

Wheelbarrow.—Paper, cardboard, or wood—Standards IV, V, or VI.

Rustic Arch and Pergola.—Twigs of willow, &c.—Standards V and VI.

Ladder.—Strip wood—Standard V.

Tools.—In wood—thin sheet zinc, cardboard, wire, &c., e.g. spade, fork, rake, hoe, scythe, besom, &c. —All classes.

Swing.—Light woodwork—strip wood—Standard VI.

III. A FARMYARD. (See Plate.)

Railings and Posts.—Paper as in Poultry Yard.

Gates and Posts.—Cardboard.

Barn.—Cardboard—roof thatched with raffia stitched on with thread.

Cart Shed.—Cardboard—corrugated iron roof from corrugated cardboard used in packing books or glass.

Pig Styes.—Cardboard—plasticine paving imitating blue bricks. Slope and drainage needs special attention.

Well.—Working model in cardboard. Copper wire spindle and handle.

Roller.—Paper cylinder—wire spindle and wooden shafts.

Wagon.—Cardboard—wooden axles and shafts.

Chicken Coop and Rabbit Hutch.—Thin cardboard.

Pigeon Lofts.—Paper.

Farmhouse.—Cardboard.

IV. A DOLL'S HOUSE. (See Plate.)

Scheme of Construction.—Each room made from a wooden box (grocer's packing case), 24″ × 18″ × 12″. Scale, 1¼″ to 1′; dimensions of each room, 19′ × 14′ × 10′.

Colour Scheme for Each Room.—(*a*) Practical lessons with coloured papers for walls and floor coverings; colour harmonies and contrasts. (*b*) Designing of suitable friezes to match the various wallpapers; simple stencil designing and cutting; the value of repetition in design.

Designs for Doors.—Observation of typical doors. Ledged, ledged and braced, framed and panelled. Selection of suitable designs for various parts of house. Models in cardboard and light wood.

Designs for Windows.—Observation of typical windows. Sashes, lattice windows, bay windows, French windows. Shape of panes of glass—diamond, oblong, square. Selection of window designs for each room.

Fire Places.—Paper and cardboard models of good patterns.

Picture Frames.—Paper, cardboard, and light woodwork.

Furniture.—Construction of various articles in suitable materials—paper, cardboard, wood, wire, &c., e.g. chairs, couches, tables, cupboards, fenders, grandfather's clock, settee, bedsteads, washstands, kitchen dresser, &c.

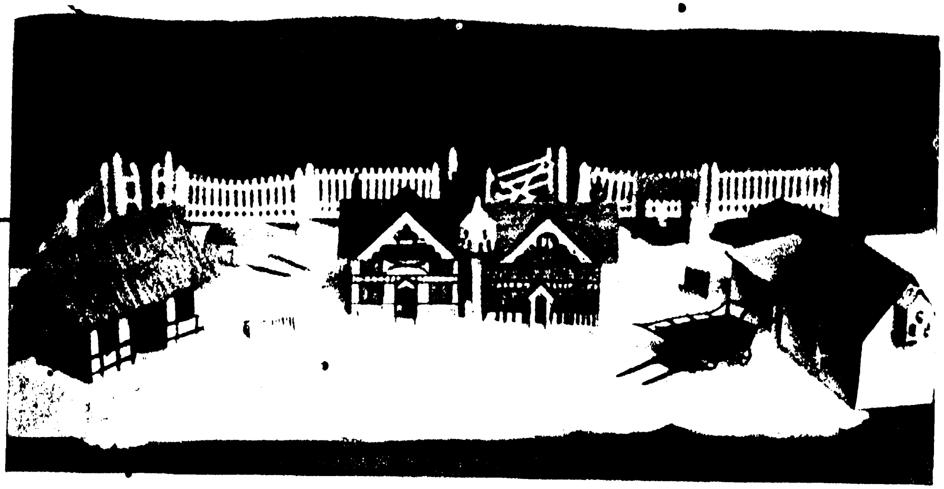
Roof.—Practical lessons and observation. Pitch, roof trusses in light woodwork, collar beam, king post, queen post, hammer beam. Roof coverings—Tiles, slates, &c., slates cut from stout paper and laid according to rule; reasons for lap, &c. Gutters—Light wood or cardboard. Stack pipes—Paper cylinders. Ridge tile—Carton paper.

Chimneys.—Cardboard models.

Facia.—Designs in cardboard.

Stairs.—Typical pattern for each story. Paper or cardboard models. Baluster in light woodwork or cardboard.

Porch.—Paper or cardboard model. Pillars and canopy; steps.



A Farmyard. A Cave Dwelling. A Doll's House.

Facing p. 206

COMMUNAL WORK IN HISTORY

The accompanying illustration shows a large model about 4 ft. long, built of brown paper over a foundation of bricks and boxes. The picture gives but a faint idea of this model, the original of which was rendered in natural colours by means of pastels. The model formed the basis of a series of lessons on the "Early Cave-men" to the lower standards. These were based on Miss Katharine Dopp's excellent handbook published by Harrap.

As the lessons proceeded the children were allowed to give free expression of the various incidents in the lives of the characters, and produced an excellent series of models in various media to illustrate the story. In this way they are led to understand the difficulty of securing food, shelter, and clothing that confronted such primitive races. The cave-dweller's home was more or less an isolated unit which led ultimately to grouping of families for the purpose of protection and communal life.

The life of the Red Indians was selected as a further type of study. Here we have a more complex communal life. The tent becomes the home, and the absence of that stress inseparable from the isolation of the primitive huntsman's life led to industrial activity and the beginnings of agriculture. Other suggested subjects for communal studies follow naturally—the consideration of life in more settled lands, a Saxon home, &c. The children are thus naturally led to consider various conditions of life in different geographical surroundings and the influence which such environment has on types of men.

Stencilling

C. V. MANLEY

STENCILLING

Stencilling is the art of cutting out from sheets of metal, cardboard, or paper, spaces, as of ornaments or lettering, which are then laid upon a surface and painted through. It is not a new art, although it has made many converts of late years, and now ranks among the fashionable hobbies of ladies and others interested in this simple and effective method of repeating designs easily. It was common among the Egyptians and Romans. Many examples may be seen by visitors to the British Museum in the Egyptian section. Stencilling is unsurpassed for the purpose of giving bold and effective ornament in antique style on walls and ceilings. It is carried out in Italy at the present day with so much care and refinement as to resemble careful handpainting. It is extensively used to decorate furniture and the spaces between windows. As a means of studying design it is invaluable. All true art is applied art. Much of the drawing taught and executed in our schools to-day takes the form of exercises which have the objects of strengthening the powers of observation of the children, and giving them some training in manual dexterity. But why stop here? Where stencilling forms part of the handwork of a school, the drawing, both geometrical and from nature, acquires a deeper purpose; the exercises in geometry are executed with a definite purpose in view; a connection arises between mechanical and free drawing; the various principles of construction are constantly being recapitulated in an interesting way; the pupil becomes acquainted with the truths of geometry in a manner which stamps them indelibly on his mind.

The teaching of design in schools has been adversely criticized, and in many cases rightly so; for the designs taught usually had no design or end in view, and when finished—there was an end to the matter. They were never applied to any purpose. Squares, triangles, circles, &c., were filled with designs, often copied line by line from the teacher's drawing, and, although this gave some facility in the use of mathematical instruments, very little educational value accrued to the exercise. Nothing like the systematic treatment of design, or the application thereof, was attempted, each class teacher being left to his own devices in the development or otherwise of this important branch of the art of drawing. In the matter of schemes generally class teachers

are not always treated fairly. The whole scheme of work should be placed in the hands of each teacher, so that he may gain a comprehensive view of the work as a whole, and so realize how to cope with the particular section assigned to his care.

Stencilling includes:—

1. *Hand-and-eye Training.*—Planning and drawing a design for a definite purpose. Cutting out the stencil plate. Printing.

2. *Colour-sense Training.*—A systematic and scientific study of colour, as far as can be done in a primary or secondary school. The teaching of colour is one of those things which is either neglected, or which just "happens". Very few teachers seem to take the trouble to acquire anything but a superficial knowledge of colour. A little time spent in studying the subject will result in a carefully graduated scheme of work from the infants' class to the highest forms in the school.

Stencilling is a form of handwork which can be used in every class in the school. It can commence with the junior children, and enough will be found in it to carry the scheme through to the highest class and even further, for many adults number it among their hobbies.

It requires no expensive tools or apparatus.

It can be carried on in the ordinary classrooms and on the ordinary school desks.

It cultivates accuracy of drawing and measurement. Careless work brings its own reward. The planning and drawing may be ever so carefully done, but carelessness in cutting will mean a design spoilt. The attention must be concentrated on the work from beginning to end.

Stencilling is not an additional subject. It forms part of the drawing course. The exercises in brush drawing or pencil work, whether from nature or otherwise, can be conventionalized to form designs.

In much of the handwork now taught in our schools the art side is often subordinated to the craft, but surely this should not be. Art and craft should be wedded and not divorced. The practical study of simple ornamentation will strengthen the judgment, improve the taste, and lead to a better appreciation and love of the beautiful.

MATERIALS REQUIRED.

The apparatus required for stencilling includes the instruments and materials used in the ordinary drawing course, with the addition of knives for cutting the plates, cutting pads, oil stones, and stencil brushes.

The stencil plates can be made from stout cartridge paper, which is rendered waterproof by brushing on both sides with a saturated solution of shellac and methylated spirit, or the liquid called "knotting" by painters and decorators. This preparation not only makes the plate waterproof, but it also adds considerably to the strength and stiffness of the plate. The waterproofing solution is applied after the plate is cut out. If the plate shows a tendency to bulge, it should be placed between sheets of cardboard or paper and pressed for a day or two, when it will usually be found to have recovered from the unequal expansion caused by the cutting and waterproofing.

For advanced work, specially prepared "stencil paper" may be used. This is oiled paper, which

will bear a great deal of use. It is fairly stiff, but thin enough to be slightly transparent. It may be laid over a design, which can then be traced. Its transparency is also advantageous when repeating one pattern close to another. Stencil papers are made in two qualities—"stout", at 3*s.* per dozen sheets (23″ × 19″), and "medium stout", at 2*s.* 3*d.* per dozen sheets. The medium quality is recommended for ordinary purposes.

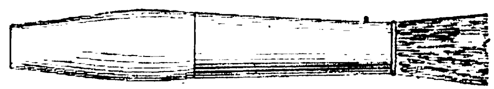
Cutting Tools.—Stencil knives of various patterns are sold by artists' colour dealers, at prices ranging from 6*d.* to 1*s.* 3*d.* each. The latter is a beautiful little double-edged knife made by Messrs. Reeves & Sons, but the price will render its use prohibitive in schools where large numbers are required. A good penknife will do equally well, provided the point is acute and not too thick. The scoring nib used in carton-paper work gives admirable results. It is mounted in a handle like a penholder. It is superior to any knife for cutting out curves and turning sharp corners, and its price, 1*d.* each, renders it possible to keep a good stock.

The chief rules to remember in using the knife are: 1. Hold it in the same manner in which a pencil is held. 2. Grasp it firmly, yet lightly. 3. Always keep the knife very sharp at the point.

Cutting Pads.—The ideal cutting surface is a sheet of plate glass. The next best is a sheet of zinc, such as is used in cardboard modelling (10″ × 6″), 6*d.* each. Millboard pads are sometimes used, but they do not give the sharp, clean cuts so necessary in this work.

Brushes. — Special brushes, known as stencil brushes, are made for this work. Messrs. Reeves make eight sizes for water-colour work, and eight sizes for work in oil colour.

The size and number of brushes for water-colour



work required for a class of forty would be as follows:—

Size 0.—2	dozen at	1*s.* 6*d.*	per dozen.
,, 3.—2	,,	3*s*	,,
,, 5.—½	,,	5*s.*	,,

It is not likely, nor is it desirable, that the whole class will be printing at any one time. These brushes should not be used indiscriminately for any colour, but certain numbers should always be used for the same colour.

Colours—Water Colours.—Cakes or pans are preferable to tubes of water colour. The brush should be slightly wetted by patting it on some such device as is used for moistening stamps. Blotting paper in small plates will do very well. The brush is then rubbed on the solid colour and applied to the stencil plate. If tube colours are used they should be spread out thinly over the surface of the palette, so that the brush does not pick up too much colour. The colour is applied by a gentle tapping motion. The brush should never be drawn across the plate, for two reasons. First, it is likely to break the ties, and, second, the colour will flow under the paper and spoil the sharpness of the pattern. The brush should never be heavily loaded with colour; the tips of the

bristles only should be charged. Many pretty shading effects may be obtained by varying the amount of colour applied to different parts of the design. The brush should never be dipped in water except to wash it. If water colours are applied to dark backgrounds it is necessary to make them opaque. This is done by mixing them with Chinese white.

Oil colours are used for stencilling on fabrics. Many of the difficulties formerly met with are now avoided by using the specially made stencil colours. These are supplied by Messrs. Reeves in glass bottles in fifteen tints. They are ready for use. No thinning medium is required. They may be mixed to obtain numberless variations of shade and tint. With oil colours more colour is used on the brush, but still care should be taken not to overcharge the brush, or the colour will spread over the fabric beyond the confines of the pattern. In stencilling fabrics a piece of blotting paper should be placed underneath the stuff to absorb any excess of oil which may run through and spread. The work should be spread out on a drawing board or table, and the wrinkles smoothed out. Fix the stencil plate with drawing pins. If it is desirable to avoid holes in delicate fabrics of silk, satin, &c., weights may be used instead of pins. The under side of the stencil plate should be kept clean by wiping it carefully, so as not to damage the delicate outlines and ties.

Washing Stencilled Fabrics.—Several weeks should elapse before attempting to wash stencilled fabrics.

Prepare a warm soapy lather. Avoid strong soaps. Place the article to be washed in the lather, and move it about quickly. Do not rub the coloured parts. Wring out lightly, and put at once into clean cold water. Rinse two or three times, and wring out lightly. When nearly dry, iron on the back, when possible. Do not use a very hot iron.

In devising any scheme of handwork the following principles should be kept in view:—

1. The instruction must go from easy to difficult.
2. The instruction must go from simple to complex.
3. The instruction must go from the known to the unknown.
4. The teaching must lay a good foundation.

In accordance with these principles the following course of work is suitable for the pupils of a primary school whose ages extend from seven to fourteen years.

As it is obvious that straight lines are easier to draw and cut than curved lines, the first exercises consist of straight-line patterns or designs.

Supply each child with a 6″ square of carton paper such as is used in paper modelling. Let him divide it into four equal parts by lines joining the middle portions of opposite sides. Each of the four 3″ squares thus produced will form the basis of a design.

Divide each 3″ square into four equal parts by lines joining the middle points of opposite sides. These lines form the guide lines when printing from the plate.

1. In the first square mark off points on the diameters each 1″ from the centre. Join these points, and cut out the resulting square.

2. In the second square mark off points 1″ from the centre of the vertical axis, and ½″ from the centre of the horizontal axis. Cut out the rhombus, or diamond shape.

3. Draw diagonals in the third square, and mark off 1″ on all lines measuring from the centre. Join the points, producing two squares. Cut out the eight-pointed star.

4. In the fourth square mark off points along the diameters ½″ and 1″ respectively from the centre. Join the points, producing two diamond shapes crossing each other at right angles. Cut out the four-pointed star.

The first trials at printing these simple patterns should be made on 6″ squares of paper which have been previously divided into 1″ squares with pencil and ruler. In repeating the pattern, note that the guide lines on the pattern must coincide with the vertical and horizontal lines on the paper. See figs. 1, 2, 3, 4 (facing page 216).

The best way to approach patterns containing curves is through brush drawing.

Simple leaves form the best preliminary practice, but other easy forms may also be included. The difficulty lies rather in the cutting than in the drawing, but practice will soon overcome this.

Continue to plan the design unit in a square or other regular figure, taking care to leave a margin and well-marked guide lines. Simple shields make very easy and effective designs. All those illustrated are within the powers of beginners except fig. 9, where the Maltese cross might be replaced by a diamond shape. Repeated as a border, fig. 9*a* produces a frieze which can be placed 'round the walls of one of the rooms in a doll's house, should the school possess one. Failing this, a number of sheets of paper (say 15″ × 20″), representing the walls of a room, may be prepared, and the design applied. The rest of these walls may be used for suitable all-over designs, as seen on wallpapers, definite colour schemes being adopted for each study. Figs. 10 and 11 are two simple studies of boats. Before applying the design, the border should be divided horizontally into two equal portions, and a light wash of blue placed on the lower half to represent water. Fig. 12 is composed of straight lines, and is a good exercise in ruler drawing and measuring. Two easy animal studies are given in figs. 13 and 14. These are very popular with children. Many others can be devised. In this case the examples are drawn from copies.

Designs may be made from the simple leaves studied in the brush-drawing lessons. At first single-leaf forms may be repeated to form a border or fill a space, and later various combinations may be tried to form a repeating pattern. In every case the invention of a stencil design should *follow* the drawing lesson. The children should be left to make their own modification in the drawing to adapt it to a design. When each child has made his effort the real lesson begins with the discussion and criticism of their work, and the classification of good, bad, and indifferent designs. The teacher's business is to introduce the difficulties gradually, and the children's business is to solve the difficulties as they occur. All criticism should be kindly given, so that the children will welcome it, and place almost as much value on it as on judicious praise. If the teacher has tact, the children will never mistake criticism for censure.

Ties.—The children will discover for themselves that some means must be adopted to prevent parts

of some designs from falling out when cut. Give them every opportunity of solving the problem for themselves, and discuss the resultant devices. Good examples for a first experiment are the letter O drawn with the brush, and a hollow square or triangle (figs. 22, 23, 24). With each individual planning his own device to prevent the centre from falling out, the teacher will have ample material for arriving at the neatest and most natural method. The goal is of secondary importance to the train of thought engendered in the process of arriving at the correct result. When planning a design the drawing is first made as an ordinary brushwork exercise. The placing of ties is then done and the plate cut. In cutting, the smaller pieces should first be attacked, as the cutting out of large portions will weaken the resistance of the plate and lead to disaster in the shape of broken ties, &c.

The nature studies done in the brush-drawing lesson may be adapted to form patterns for various purposes. Designs may be repeated in the form of bands, vertical or horizontal, or may be used to fill a space, as in fig. 27, which shows a notebook cover for nature study in pond life. Figs. 25, 26, 28, and 29 are also suitable for a similar purpose.

Fig. 32 is a design for the corners of a square photo frame with a circular opening. The picture is printed from a stencil plate. Its effectiveness lies in its simplicity.

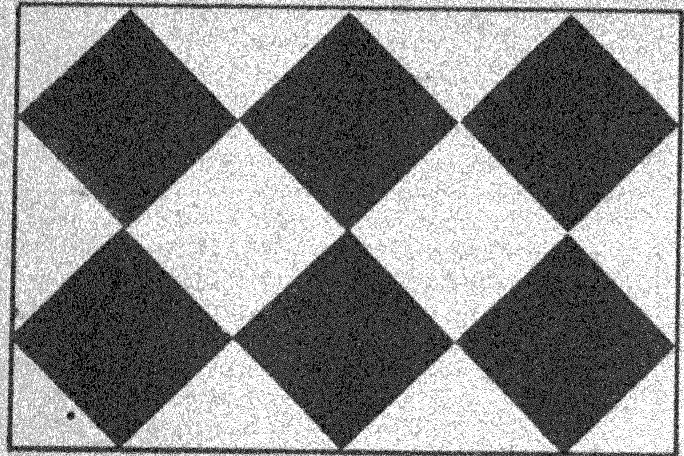
As the work advances year by year the various bases of design will be discovered and fixed by the working of numerous examples. The older scholars may with advantage study good examples of stencil designs, analysing them, and adding those worthy of note to their collections. Some excellent Japanese plates may be obtained at a small cost (2*d.* or 3*d.* each), and these form splendid studies, some of which are illustrated in figs. 44 and 45.

For the higher classes it is a good plan to obtain a disused book of wallpaper patterns from a decorator, and to allow the pupils to discover and study the various bases of design.

Some of the simplest bases are illustrated.

1. *The Square Basis* (figs. 1, 3, 33, 34).—The designs may be based on a square standing on one of its sides, or on a square standing on one of its corners, a diagonal forming the vertical axis. Fig. 15 shows a simple design which can be used in either way. Fig. 1 is the simplest form of the first alternative. Figs. 33 and 34 illustrate the point. In fig. 33 the whole space is covered by the design, while in fig. 34 alternate squares are left blank. The examination of these two examples will reveal one or two curious points. In fig. 33 a new design appears, formed by the left half of one unit and the right half of the adjoining unit, while the central stem forms a dividing line. In fig. 34 the isolation of the unit by the surrounding white squares preserves its original form. A result of this accidental discovery should lead to the planning of patterns, with the definite purpose of giving variety to the design. Units like fig. 34 may be repeated to form tile patterns. This is illustrated in figs. 41, 42, 43, each unit forming one-quarter of the tile.

2. *The Diamond Basis* (figs. 2, 35, 36, 37).—The simplest form of the diamond basis appears in fig. 2, where the repetition of the diamond shape in horizontal rows brings out a replica of the unit in white.



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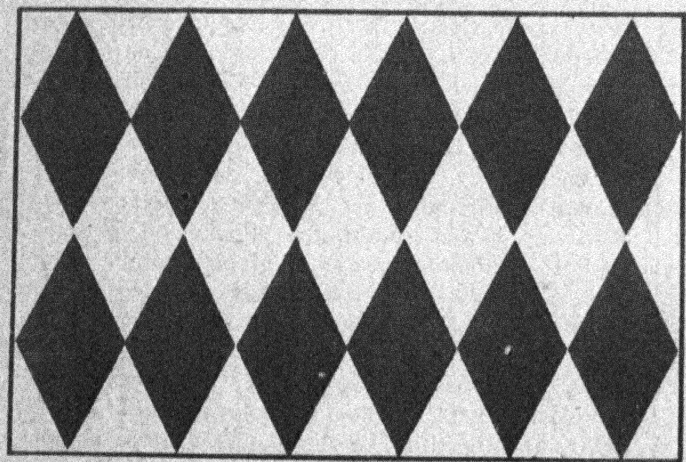

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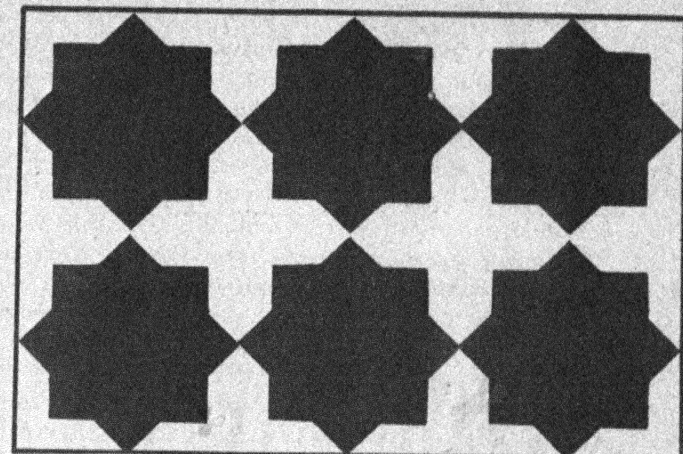

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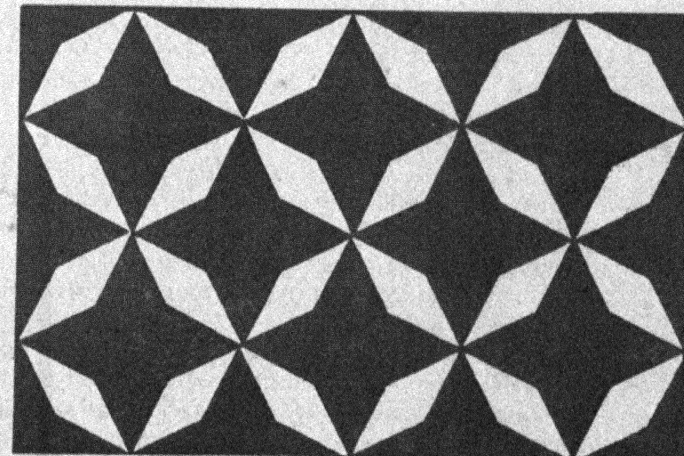

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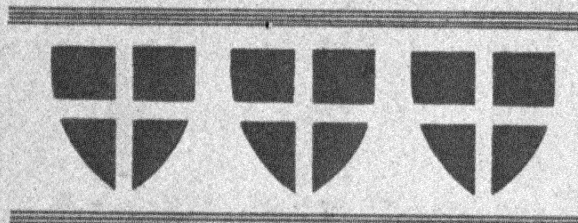

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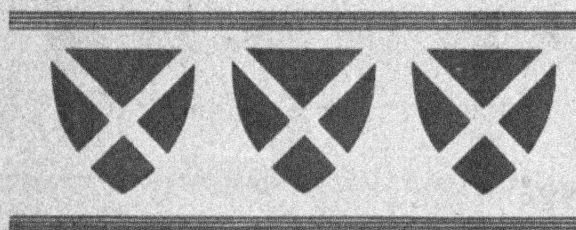

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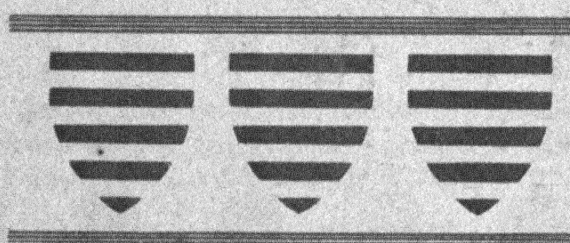

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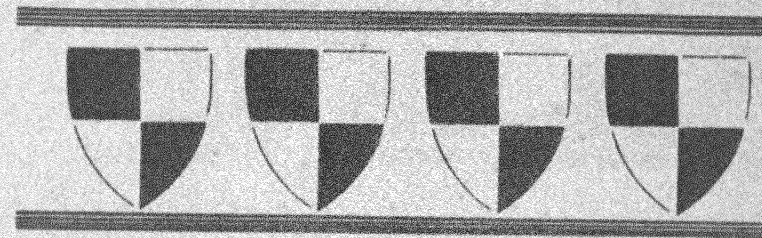

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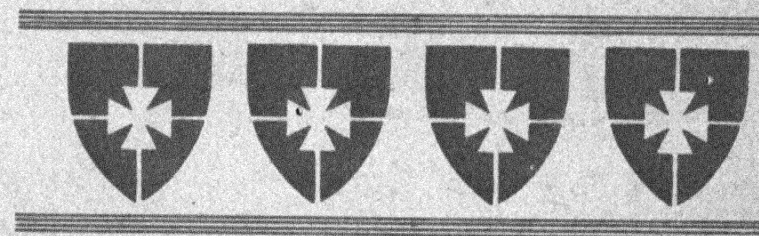

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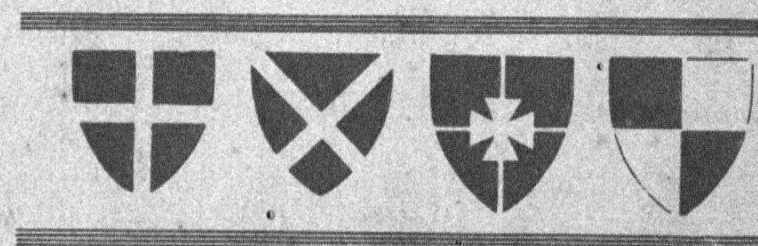

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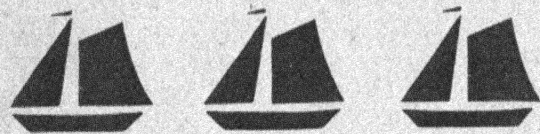

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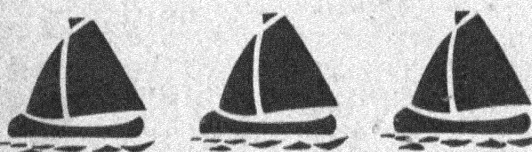

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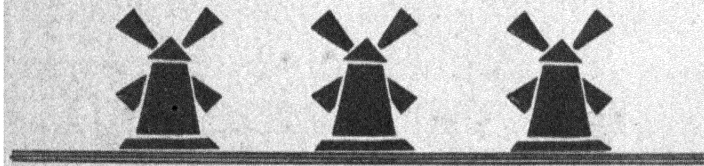

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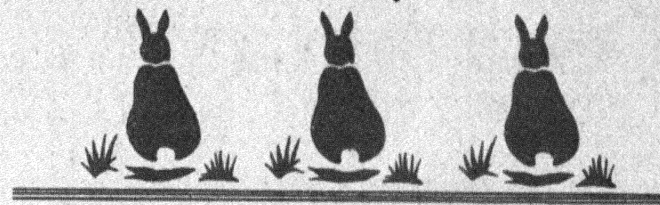

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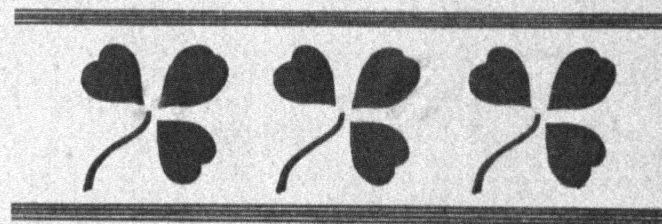

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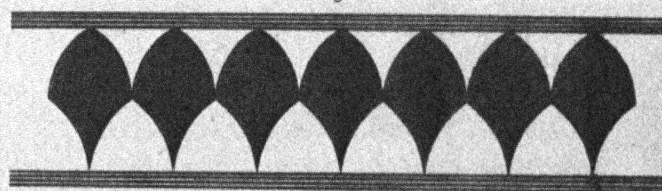

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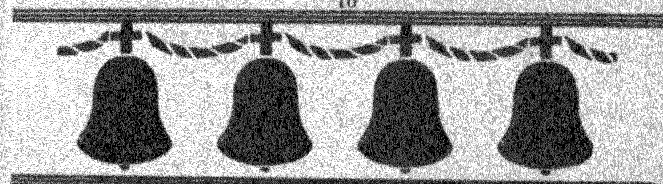

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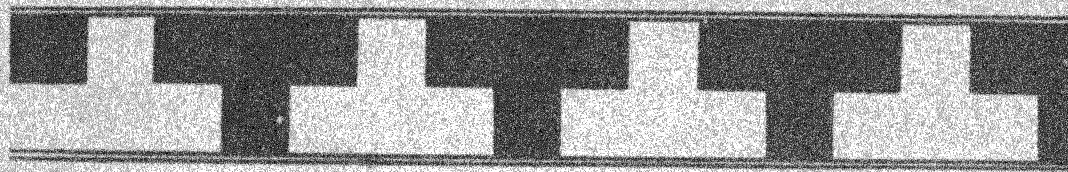

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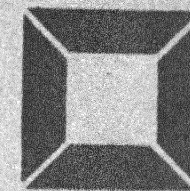

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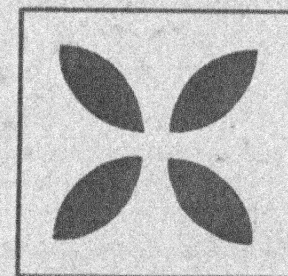

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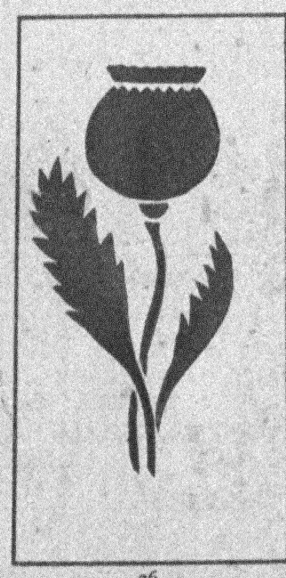

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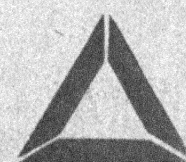

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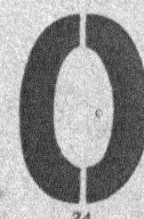

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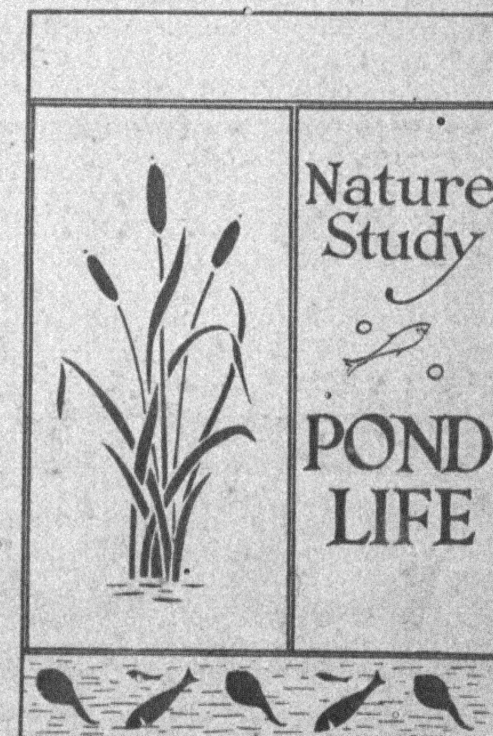

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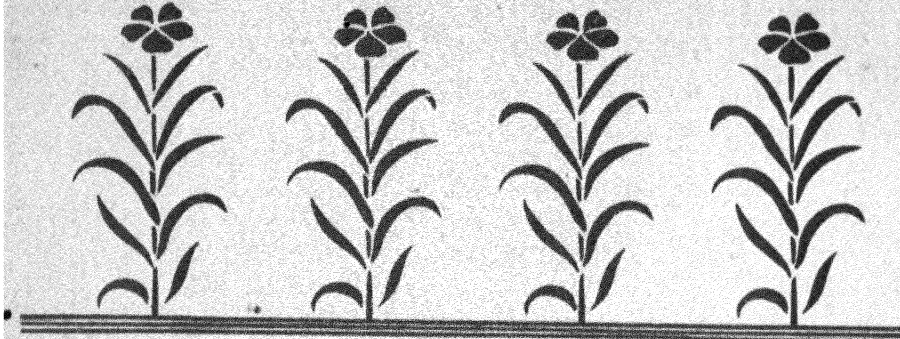

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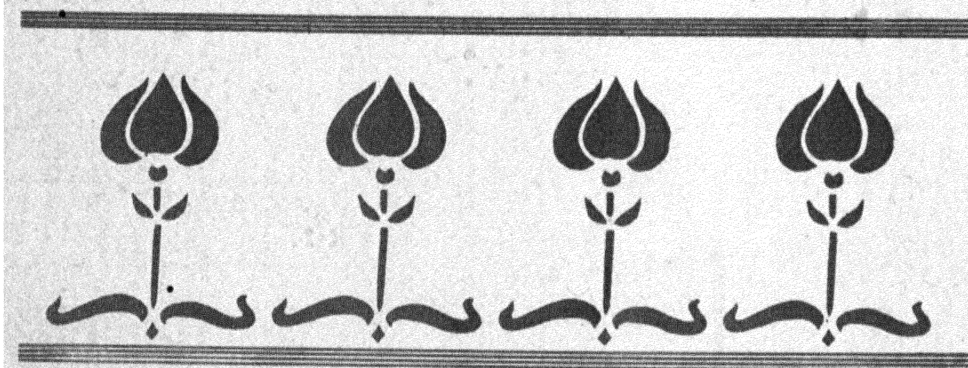

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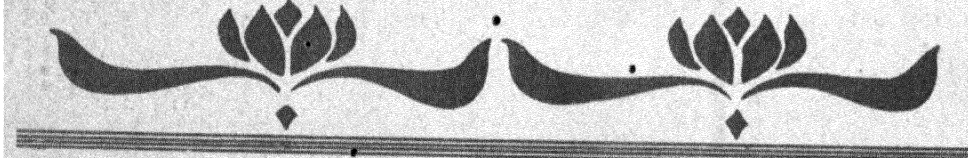

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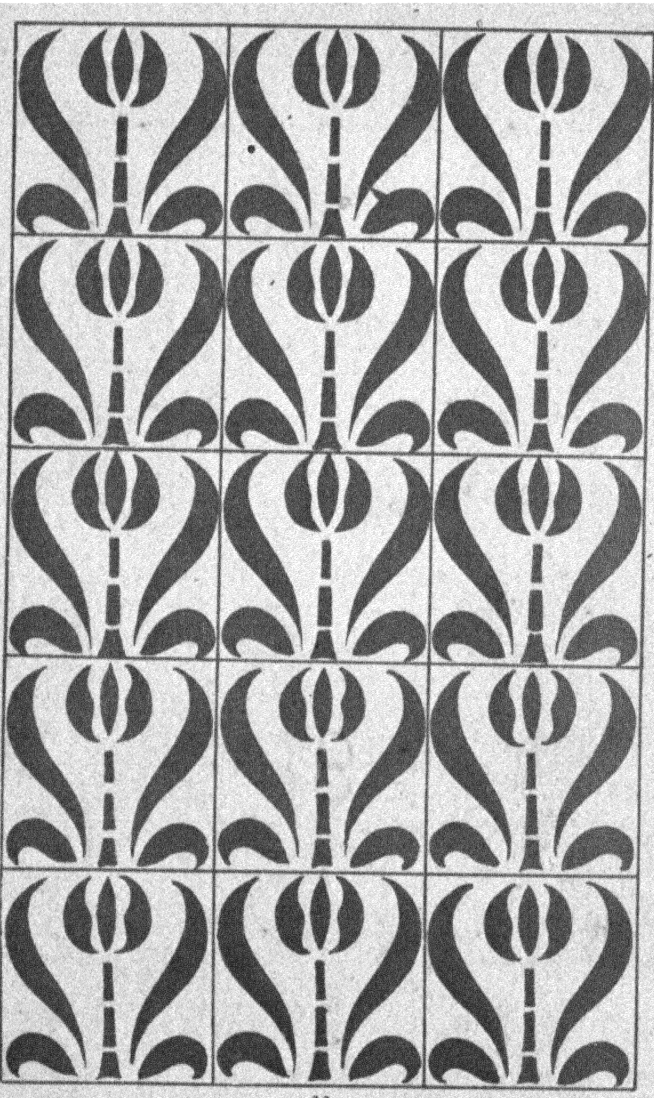

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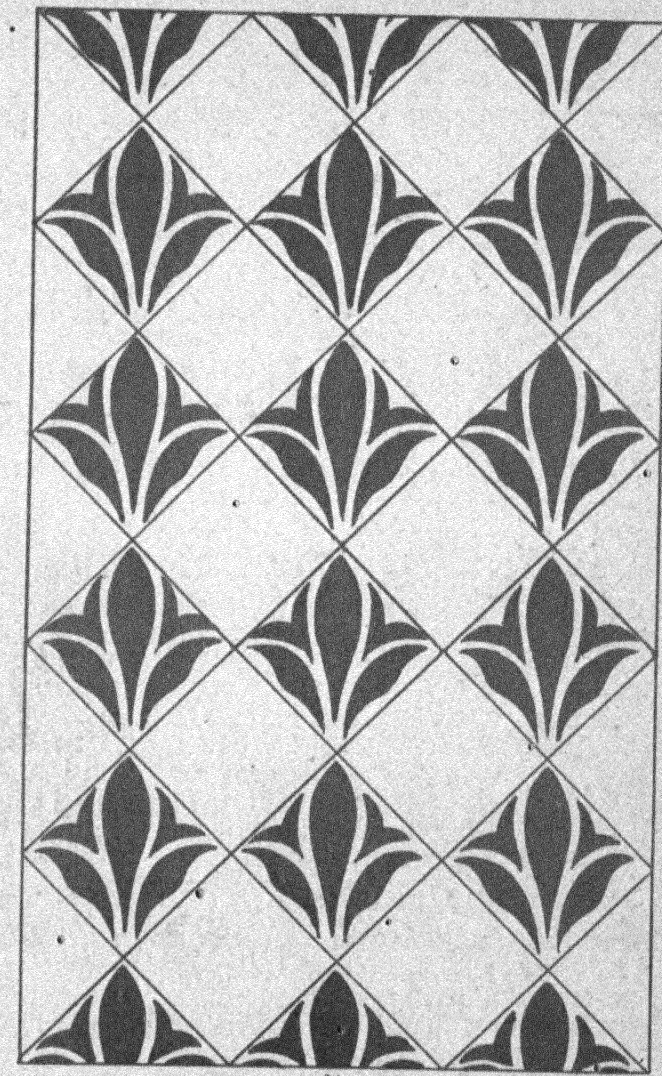

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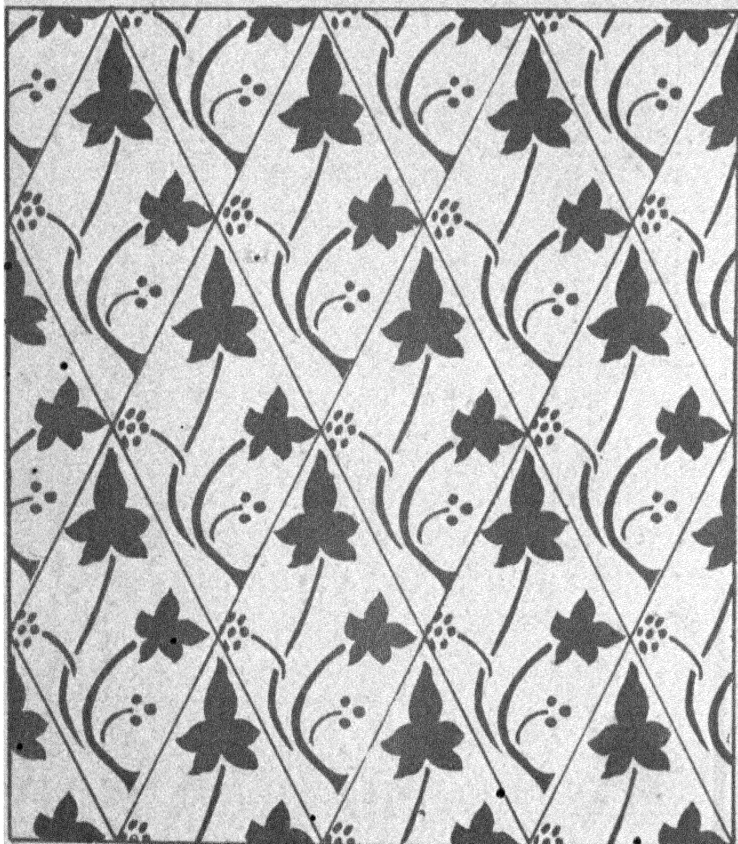

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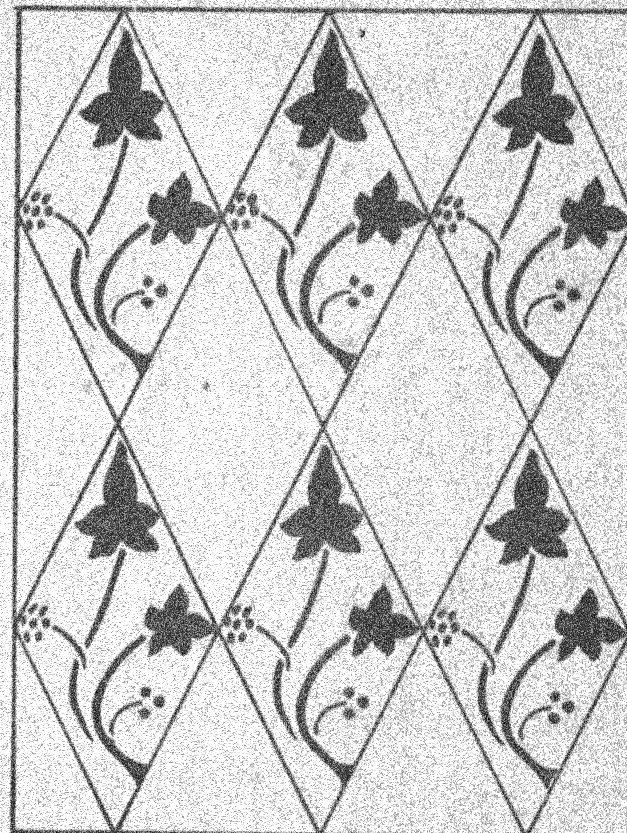

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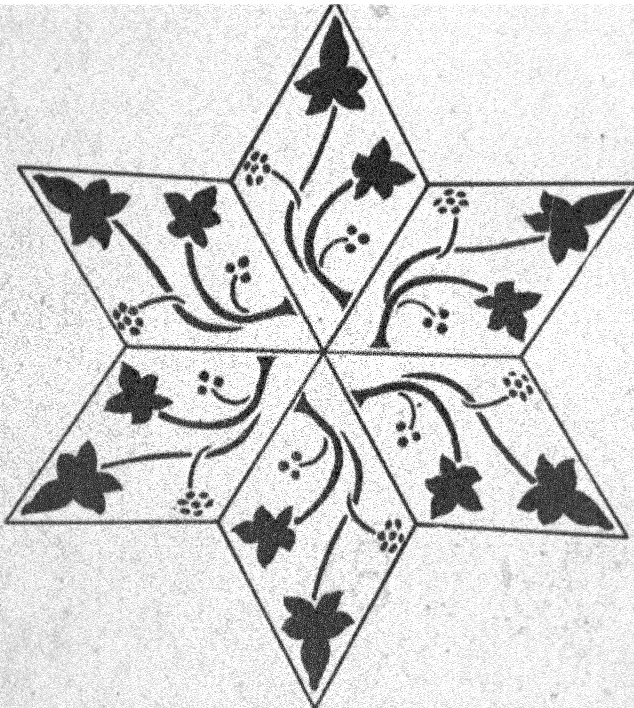

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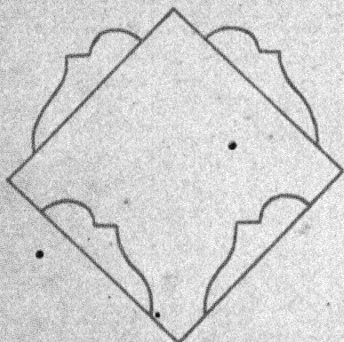

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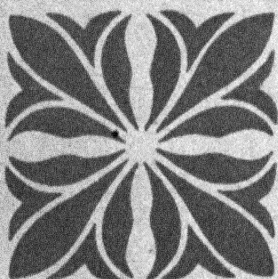

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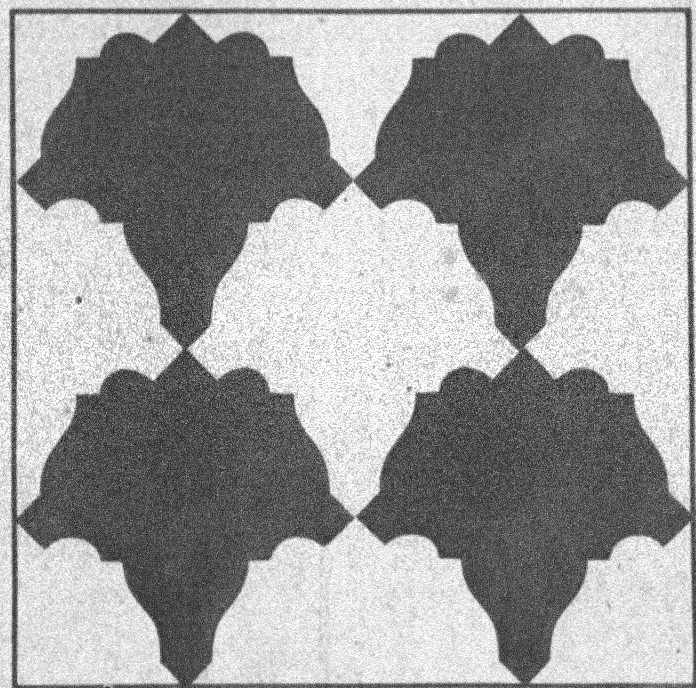

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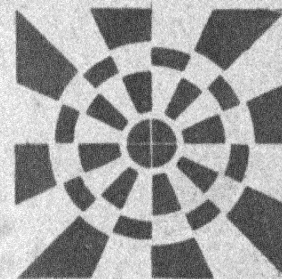

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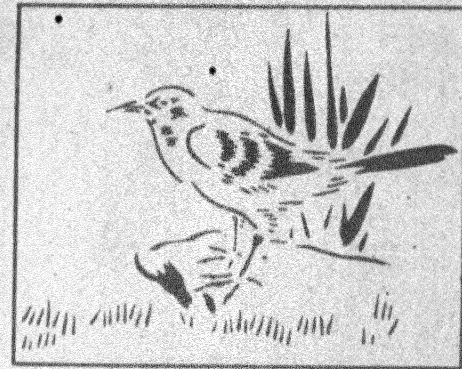
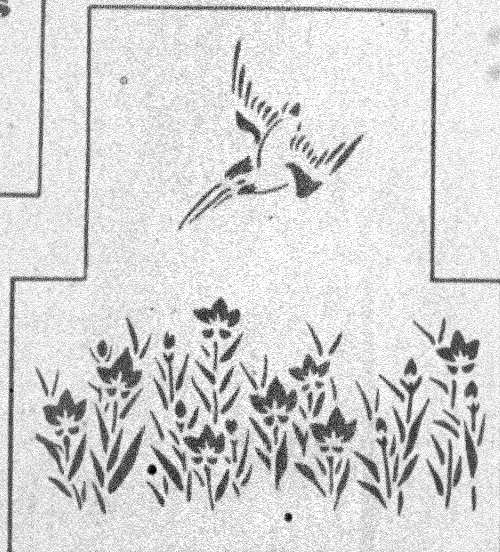
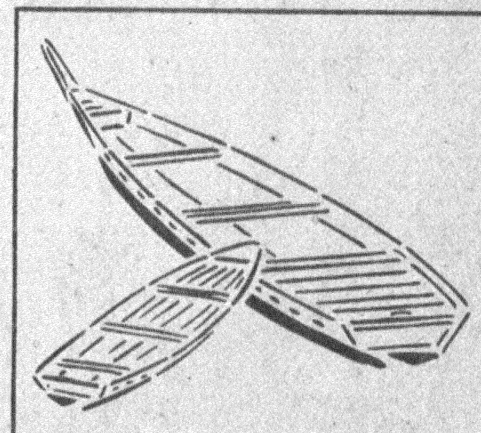
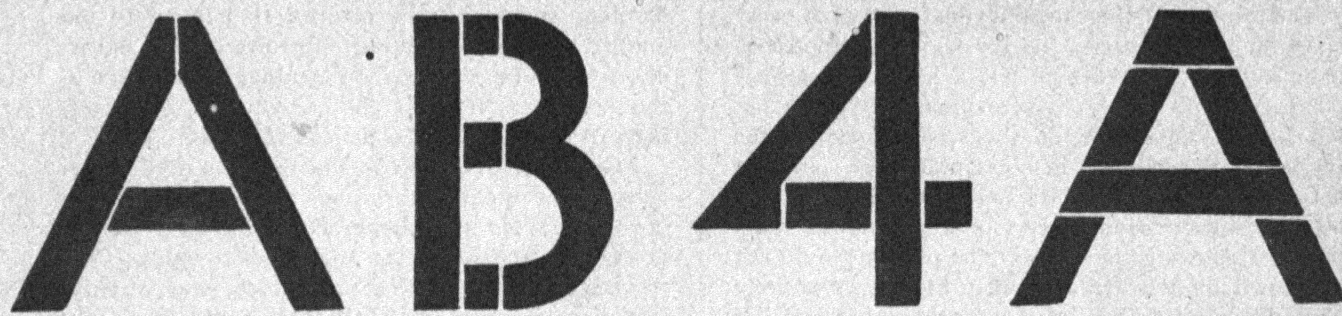






BOATS



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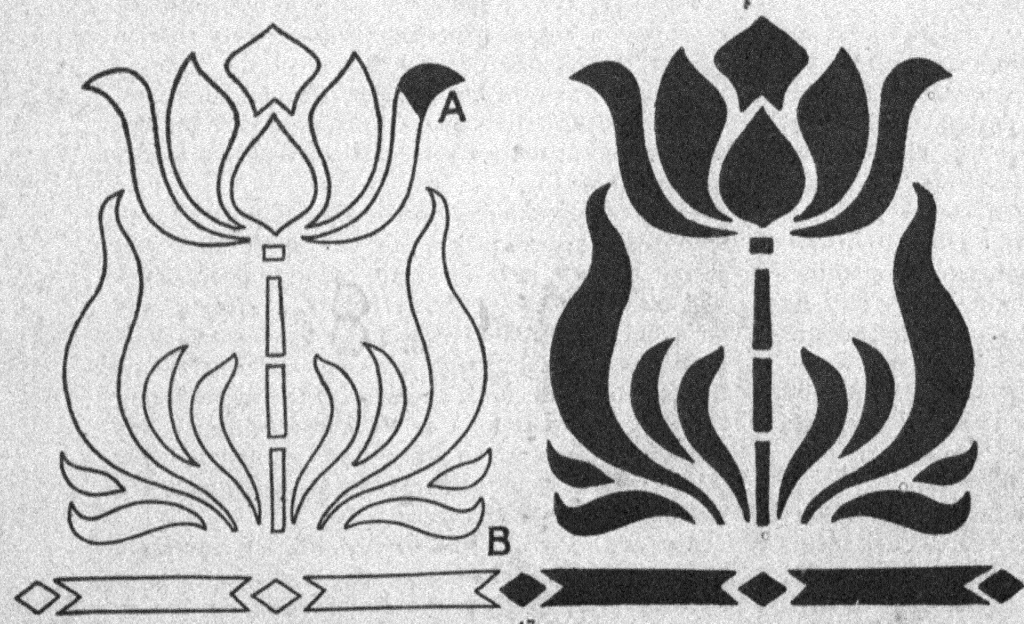


47

The printing of the simple ivy-leaf pattern in every space in fig. 35 causes the ivy leaves to appear in oblique lines. The design has a heavy appearance compared with fig. 36, where alternate spaces are left blank. Moreover, in the second example the ivy leaves now appear in horizontal rows. Fig. 37 shows the application of the unit to the decoration of a table centre or similar piece of work. In all cases the lines showing the basis of the pattern would not be drawn on the actual work. Fig. 37 is entirely altered in appearance by these confining lines. If the lines are omitted the design appears free, flowing, and natural, instead of stiff and formal.

3. *The Oblong.*—Fig. 38 shows a design based on the oblong. Instead of repeating the pattern in horizontal rows it is "dropped" one-half its length. This gives variety to the finished design. Units may be "dropped" other lengths than the one shown: one-fourth, one-third, and one-half are the commonest "drops". In designing a stencil plate to be used in this way, care should be taken to distribute the mass so that when the pattern is printed the heavy part comes against the light part. This is illustrated in fig. 38, where the top half of the design is heavy compared with the bottom half. The same principle obtains in fig. 35, where the diamond pattern is "dropped" one-half. The two ivy leaves are placed in the top part of the design, while the bottom part contains only light stems and berries.

More complicated designs could be planned, where the pattern occupies two or more spaces, but these are beyond the scope of children, except perhaps the very highest class. At present the designs should spring from simple units, each one complete in itself. Trailing stems may be planned to join on to one another, thus giving an idea of growth. This is very effective in designs based on climbing plants such as the sweet pea, the hop, the convolvulus, the blackberry, the bramble, the honeysuckle, &c.

Tile Patterns.—Fig. 39 illustrates a well-known rule used in making an ornamental tile unit. From the lower sides of a simple all-over shape a portion is cut out and added to the opposite sides. The result is a new symmetrical unit, which, when repeated in horizontal rows, shows the same unit in the white spaces left by the pattern (see fig. 40).

Figs. 41, 42, 43 show tile patterns produced by repeating a square unit four times. Note that in fig. 42 the quadrant in the corner of the plate by repetition forms the circle which occupies the centre of the tile. In the same way corners may be also made to repeat to form some distinct shape surrounding the whole tile.

Many other examples and devices might be given, involving various principles, but space does not permit of their inclusion here. Many opportunities will occur for the study of actual specimens, and boys and girls should be encouraged to observe good examples, making rough drawings in their sketch books for more accurate geometrical treatment during the time set apart for this work in school. In this way the pupils learn to observe and assimilate many things which would otherwise not receive even a passing glance or thought.

Method of Repeating a Design.—Fig. 47 represents the method adopted for repeating a design to form a border. In making the stencil plate the design is printed twice, the required distance between the

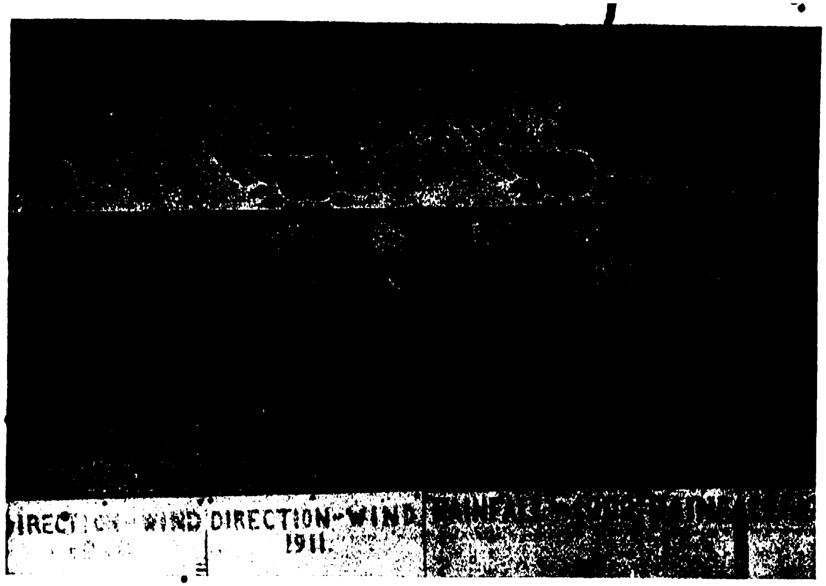
repeated units being thus fixed. The second pattern is cut out as shown, and two portions of the first tracing, A and B, are also cut out. It is now an easy task to repeat the design. When the unit is first printed, all that is necessary is to move the plate to the right so that the portions A and B cover the corresponding parts of the printed design, when a second repeat of the unit can be printed in the right position. In time the operator will be able to dispense with the whole of the pattern as traced in outline, and will only leave portions as A and B to fix the distance and position, but at first it is advisable to have the two units on the plate as shown.

Letters.—It is sometimes useful to have a set of letters in stencil form. In schools this is not so necessary, as any lettering to be done on Christmas cards, book covers, and similar work is much better done direct with brush or pen. It is found in practice that constantly recurring titles on charts and diagrams are better cut as whole words and not as separate letters. For example, in the illustration will be seen a set of wind and rain charts, one for each month of the year. The title "Wind and Rain" is printed from a stencil plate. The names of the months also form a set of stencils, the figures for the year being on a separate plate. The cardinal points, N, S, E, W, and NE, SE, NW, SW, are also printed from stencils. With this equipment a boy produces a uniform set of twelve charts printed in two colours ready for use in the class. All that now remains to be done is to paste on strips of coloured paper to indicate the direction of the wind each day, a red strip recording a dry day and a green strip a wet day. As they are finished, the diagrams are placed in order on the wall, which just holds the twelve charts in a row. At the end of the year the results are tabulated in yearly diagrams, as seen on the right, three years always being kept up for comparison. The uniformity of lettering and colouring of these charts adds distinctly to the appearance of the room, and the ready reference in geography lessons, &c., is invaluable.

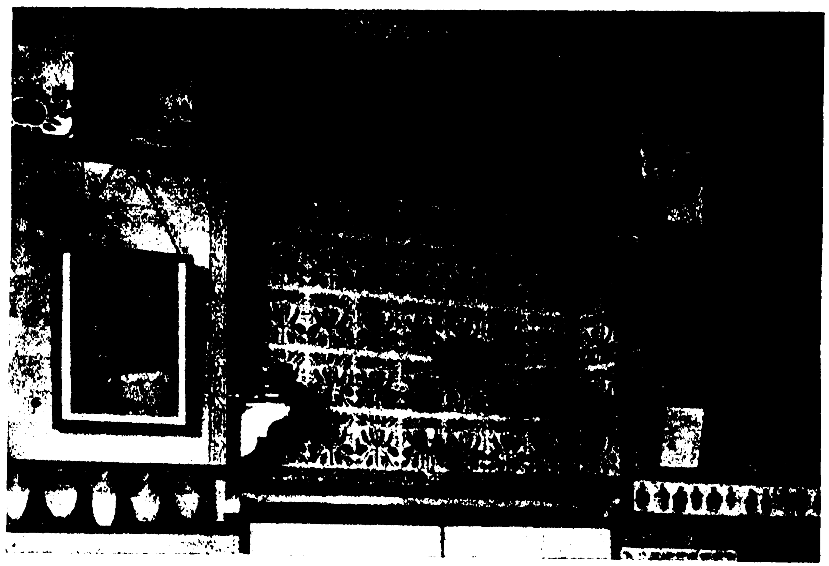
If it is thought necessary to have a set of letters cut for general use they should be carefully planned so as to avoid ugly ties. The best guide is to adopt a uniform system in placing these ties. By a uniform system is meant that the ties should be all of the same kind, and should run in the same direction. They may be on the vertical plan, where all ties will run from top to bottom of the letters, or horizontal, where they will run from side to side.[1] Examples of letters and figures in each style are given in fig. 46, and from these the alphabet can be constructed with a little thought. In asking an upper-class boy to design an alphabet and set of figures he should be given the idea (if he required it) in a few letters only, and allowed to apply it to the rest. One of the by-products in the art of stencilling is the making of blocks by printing the plate on plain linoleum and cutting away the surface left blank. This, when mounted on a wooden block about ¾" high, forms a line block from which hundreds of copies can be printed in a letter press by rolling with printer's ink, laying the paper on the block, and subjecting to

[1] In either case an occasional oblique tie is permissible where it can be placed naturally, as in the letter A in the vertical series, and the figure 5 in the horizontal series.

STENCILLING



Photograph showing practical application of Stencilling in frieze round school walls. Original design executed in green and orange



Photograph showing practical application of Stencilling filling up bare space on school walls—Original designs

pressure. In this way may be produced effective programme fronts, &c.

As already pointed out, apart from the craft side of stencilling, the child receives a sound education in the use of colour which the ordinary course of drawing scarcely touches. Many girls and women can tell when two colours will go well together, but they cannot tell why they harmonize, and they must see them placed together before they can decide. Colour enters so largely into everyday life that it is worth while to give the study a more prominent place in the curriculum. This does not mean an extra subject. Drawing, both with brush and pastel, handwork, &c., offer many opportunities for its practical application. It should be a guide to the choice of covering papers and leatherettes for models, and to the selection of appropriate colour for a design to be placed thereon. Whatever scheme of handwork may be taken, colour contrasts will be required, and a knowledge which will result in perfect combinations is well worth the little trouble taken to acquire it. "This cultivation of the sense of colour is psychological rather than physiological. It is not the organ of vision that is improved, but the power of interpreting and co-ordinating the sensations which it transmits to the brain." The teaching of design through the medium of stencilling leads to a thorough study and appreciation of colour contrasts. No one who conscientiously works through the course need have any fear of the result. The drawing will be more accurate, the observation will be strengthened, and the knowledge that some real and useful end will be served, or, in other words, that the art will be applied, will give an added value and zest to the work, which will be shared both by teacher and pupils.

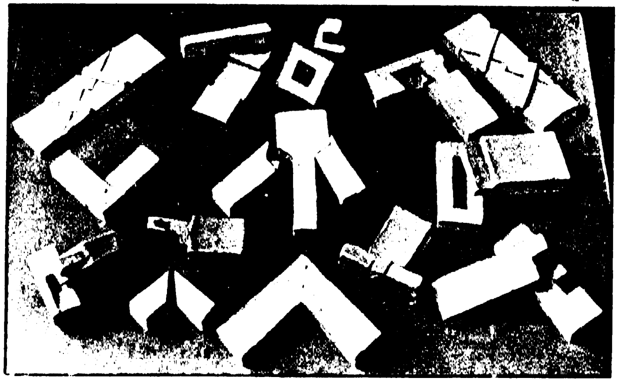
The designing and cutting of stencils form an excellent handwork exercise for all the classes of a school. The designs may be used in many ways, e.g. decorating book covers, models, &c., or may be applied, as in the illustrations, to the beautifying of some blank space on the school walls.

The two accompanying illustrations show—

1. A conventional floral frieze in green and orange painted round the walls of the schoolroom. The row of shields fixed to the wallplate are of a temporary character only, being made of cardboard and painted to illustrate the elements of heraldry to enable the boys to read intelligently Sir A. Conan Doyle's historical novel *The White Company*, Scott's *Ivanhoe*, &c.
2. A walled-up window space showing filling design and border. The size of the design was fixed by measuring the space to be covered and dividing into oblong units, allowance being made for the border. The unit width was the depth of the window. The stencil is dark green on a light-green background.

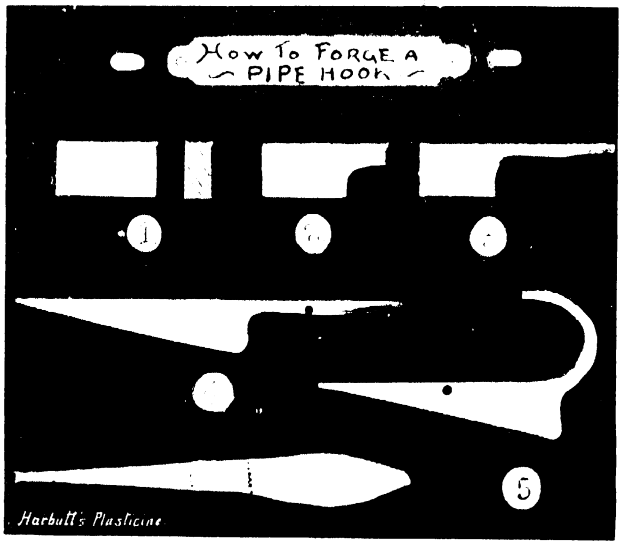
Plastic Craft

J. L. MARTIN



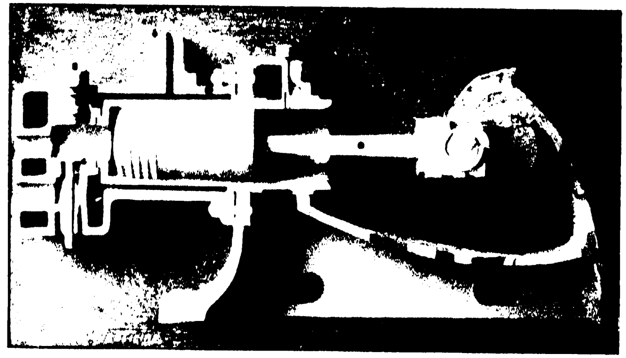
No. 1

Woodwork in Building Construction



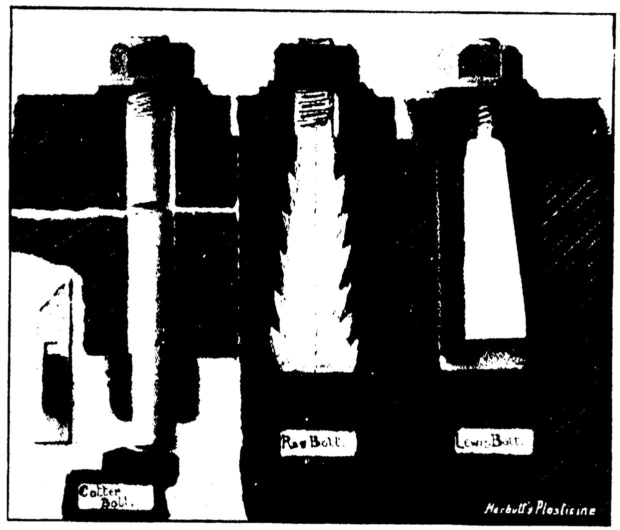
No. 2

Blacksmith's Forged Iron



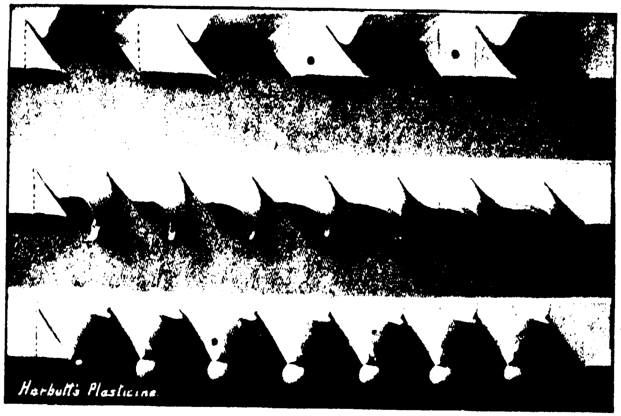
No. 3

Model of Gas Engine

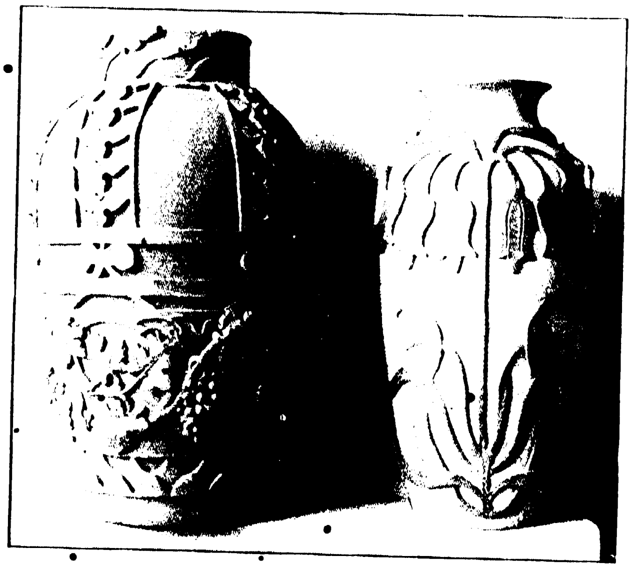


No. 4

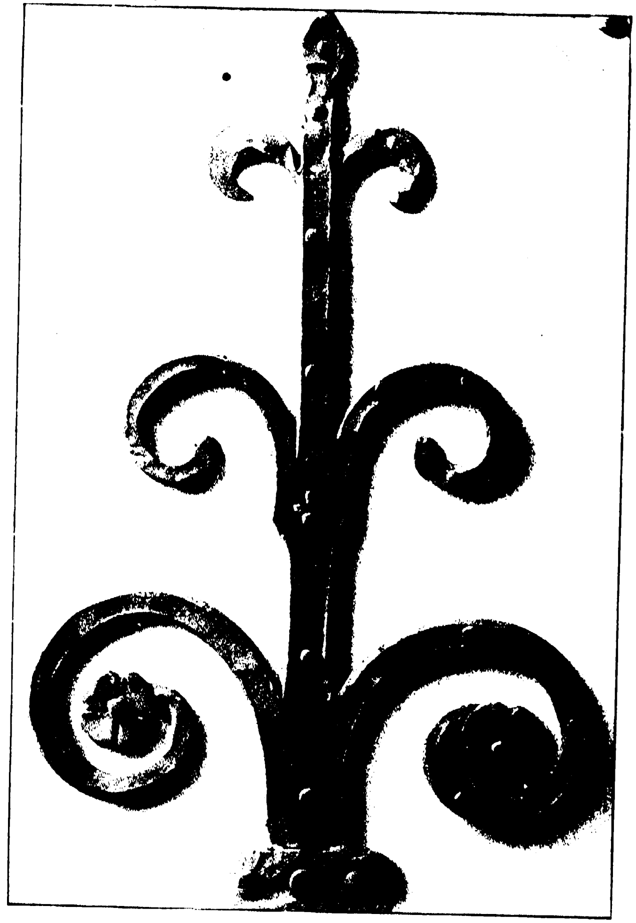
Plastic Model of Engineers' bolts: "Cotter", "Rag", and "Lewis"



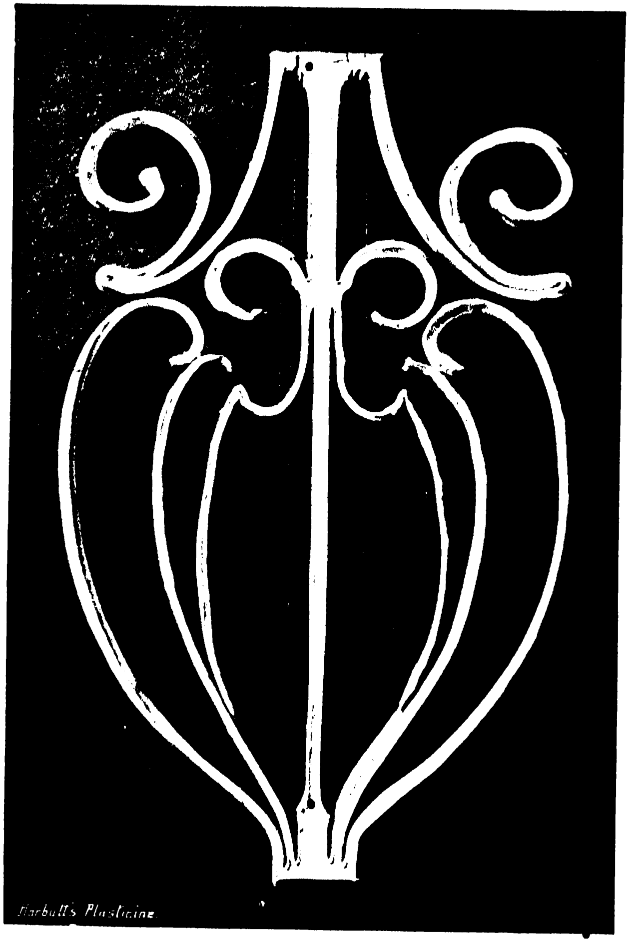
No. 5
Sheet Metal—Decorative Elements



No. 6
Decorative Appliqué Work

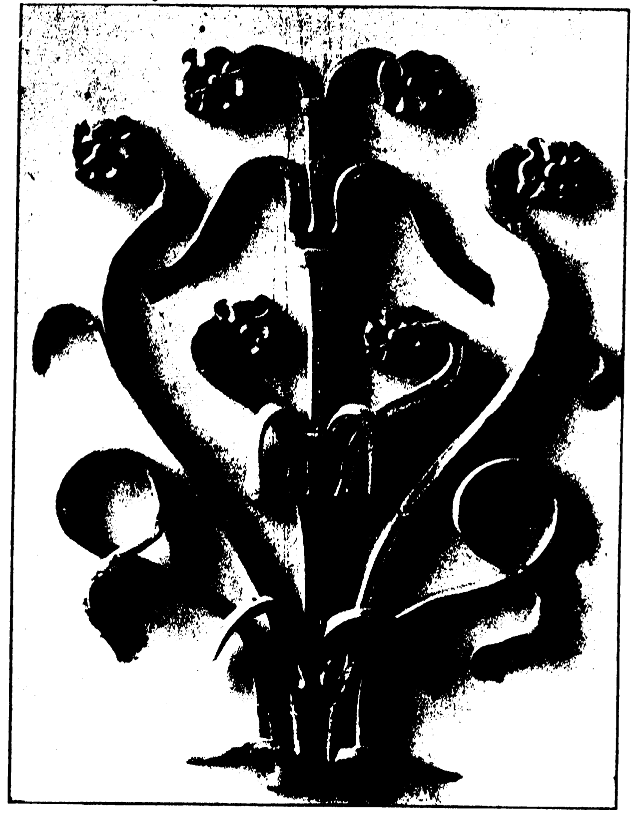


No. 7
Forged Iron Hinge



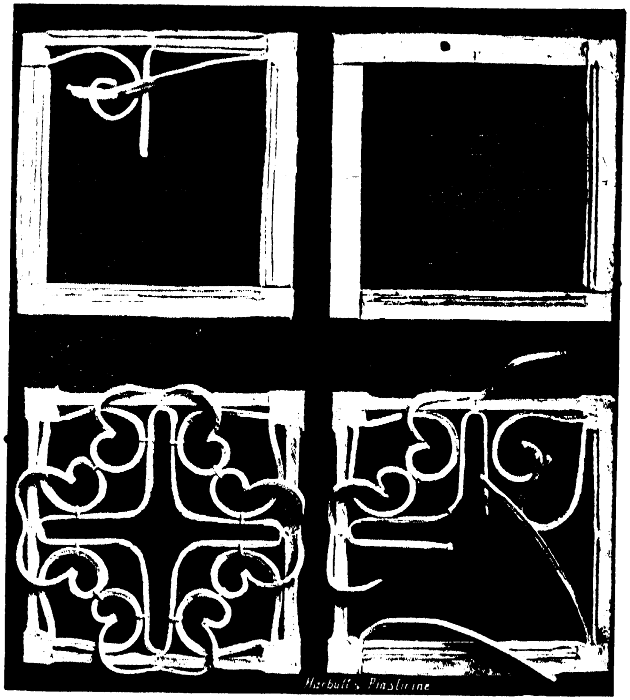
No. 8

Bent Iron for Gates



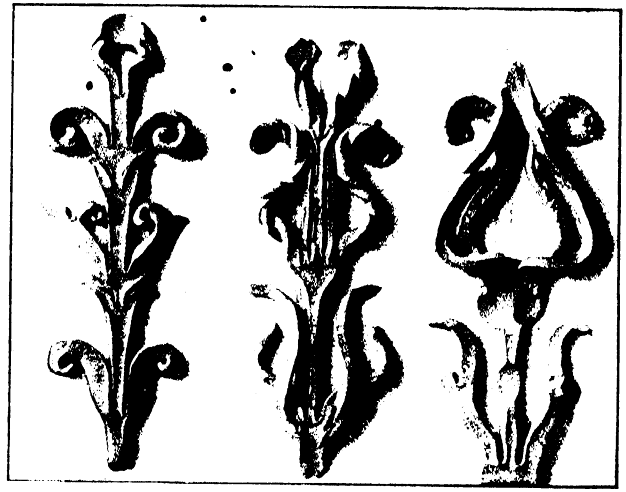
No. 9

Design by Schoolboy for Gate



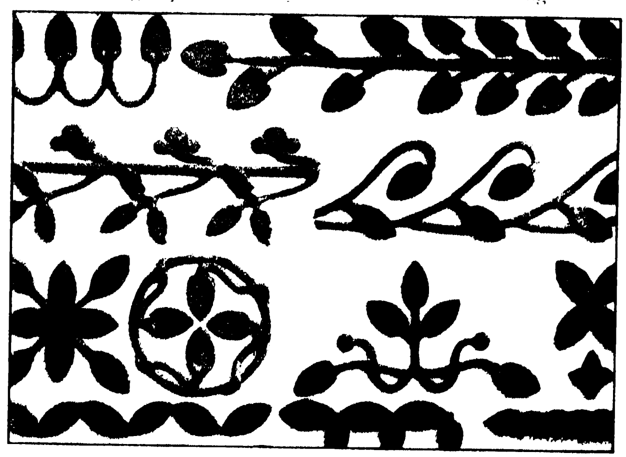
No. 10

Bent Iron for a Grill



No. 11

Design by a Schoolboy for Stone or Wood Carving



No. 12

Designs for Stencil Cutting, Needlework, or Appliqué

PLASTIC CRAFT

By the use of a stiffened Plasticine, ductile and tenacious—in connection with cardboard, wire, and light wood strips—many of the constructive arts and crafts can be intelligently anticipated and studied in the Elementary Classroom (age 5–11) before the period when the pupil can with advantage be placed under the care of expert manual-trained teachers.

Although plastic in all its stages, the work must not be confounded with ordinary art modelling.

Plastic craft takes fullest recognition of the distinction drawn by the Board of Education between the two main elements which should be embodied in any satisfactory or successful scheme of handwork in the school, viz. the artistic and the constructional. The first develops the artist, the second the artificer—the skilled and useful workman.

The Board of Education emphasizes the value and necessity of the "mechanical", the "geometrical", the formative aspect in handwork quite as much as in the imitative art study of nature, and rightly so, as the constructive enters more directly into life and living and to the applied uses of everyday existence.

This article does not profess to cover the ground, but is a small and practical contribution to the problem which so many are working at to-day. Plastic Craft meets many of the conditions resulting from crowded classrooms, congested timetables, restricted funds, and the absence of fully trained specialists in teaching. It can be taught by the ordinary staff at the ordinary desk with no expensive equipment, and is intimately correlated with brush drawing—it carries on the proper discipline of the hard pencil-point drawing from nature into a freer expression of utility.

It is not desirable to have elaborate directions to learn technique and manipulation—let the children try experiments and find out methods for themselves.

It is proposed to teach Plastic Craft in all cases by such apparent photographic charts as No. 2 (Iron hook) in accompanying illustrations. Expensive models and tedious directions are not needed, an appeal to the perceptive faculties through the eye is sufficient and self-explanatory.

The illustrations are given as suggestive of Plastic Craft in the direction of Woodwork (No. 1); Forged Iron (No. 2–4); Repoussé plastic applique (Nos. 5, 6, 8), &c.

The preceding section, written by Mr. Wm. Harbutt, A.R.C.A., together with the accompanying

diagrams, illustrates clearly that a considerable amount of ground in the direction of a training in craftsmanship may be given to large classes of children through the manipulation of plasticine, in an inexpensive manner, with no waste of material, before the age when costly tools are needed. As stated in the "Circular on Manual Instruction" issued by the Board of Education, p. 8: "Any complete Handwork Course which is to be in touch with the school work as a whole will contain two main elements. There is in the first place the kind of work which requires the child to express his impressions of objects either from direct observation or from memory. This is handwork in its more artistic aspect, and its chief medium will be found in modelling, &c. On the other side is the more exact or geometrical kind of work which involves accuracy in measurement and develops what may be called in the broad sense the constructive faculties of the child."

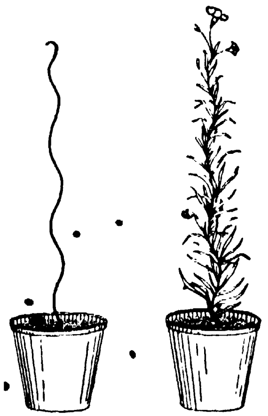
Figure No. 1 (Woodwork) shows the use to which a plastic material may be placed in acquiring a knowledge of the various joints used in carpentry. Young children are very readily disheartened. All woodworkers know the disappointment which repeated failure brings, to say nothing of the waste of material; and it is of very considerable assistance to a beginner who has a difficult joint to make if he first observes a completed model, constructs it in plasticine, and then proceeds to the more exact work in the rigid material. It is not necessary here to describe the method of construction of these various joints. Readers are referred to any good manual on the subject.

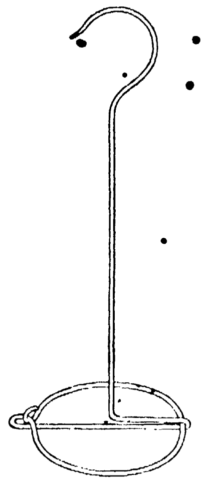
WIRE WORK

As a further development of this plastic craft, children may be encouraged to complete simple exercises in metal work. Cold metal work, including the use of wire, bands or strips of various kinds, and sheet-cutting, forms an admirable introduction to the use of certain tools, and is a suitable preparation for work with forged or heated metal. Such simple metal work is required in every home and in various directions. The initial stages would include exercises in the construction of simple articles from wire of various kinds. The cost of the material is small, varying from 6*d*. to 1*s*. 10*d*. per pound. A lead pencil and round ruler, a pair of snips and round- and square-nosed pliers provide all the tools which are necessary at first.

The lead pencil and round ruler are useful in making curves, although the work will be greatly improved if the anvil illustrated on p. 226 is obtained. The children may be invited to bring articles made of wire from their homes as models. These may be examined and the method of construction discussed. Many suitable articles readily suggest themselves, e.g. wire puzzles of various kinds, an egg whisk, toasting fork, skimmer, tripod stand for hot plate, a bill file, strawberry protector, carnation trainer, fern or orchid basket, flower-pot stand, tumbler stand, photo frame, &c.

It is not necessary to give detailed directions as to the construction of the various models in this section, as a careful examination of the suggested examples will show that there are certain general principles of construction common to all.





1. CARNATION TRAINER.

This is a simple exercise in the manipulation of medium wire. The trainer is very useful, as it is practically invisible, and tying is rendered unnecessary.

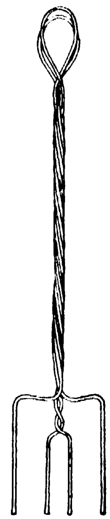
2. BILL FILE.

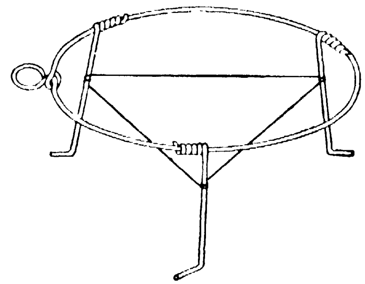
Galvanized wire $\frac{1}{10}''$ thick is suitable for this exercise.

The circle at the base is first made by straining, using the round ruler. The method of clipping is shown in the diagram. The long end of the wire is bent to form the diameter of the circle. It is looped round as indicated, and at the centre is bent perpendicularly and finishes with a hook.

3. TOASTING FORK.

An examination of the diagram will show that two strands of medium wire, one longer than the other, will be required. They are bent in the middle round the ruler to form the handle; the strands are then twisted tightly together for about 10″. The two longer wires are bent to form the outer prongs, whilst the two shorter are twisted once more to form the inner. The wires must be cut so that the ends are in a line. The ends are then hammered flat.





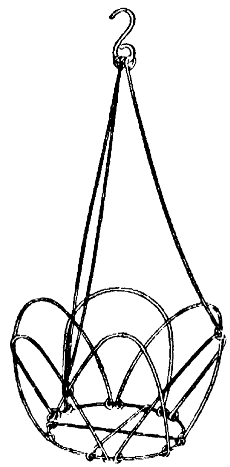
4. TRIPOD STAND FOR HOT PLATE.

Stout wire will be required for this exercise. The loop for handle is first made. The wire is then turned to form a circle, and is finished by clipping to the handle.

Three lengths of wire are used for legs. They are fastened by coiling as shown in diagram. The other ends are bent to form the base. The three legs are held in place by a piece of wire coiled twice round each.

(This may be used as a protector for strawberry plants.)

5. HANGING FLOWER STAND.



This model should be made of thin copper wire.

The base is a circle 4¼″ in diameter, having two stays fixed at right angles to each other, and clipped to the circle.

Six pieces of wire 12″ in length are required to form the sides, which are bent somewhat in the form of a horseshoe, as shown in diagram. As they have to bear a considerable strain, special care will be necessary to secure the clips to the circular base.

Three strands of wire about 12″ long are then fastened from alternate points of intersection of the curves. These are fastened at the top by loops passing round the closed end of a spiral hook.

It will be noticed that when heavier wire is used for such articles as a frying basket, fern basket, flower stand, &c., the joints are fastened by means of binding with fine wire. This kind of work will generally be beyond the strength of young pupils.

BENT-IRON OR STRIP WORK

This is said to be the easiest of all the arts in metal.

MATERIALS REQUIRED.

Tools.—(Five of each for class of twenty.)

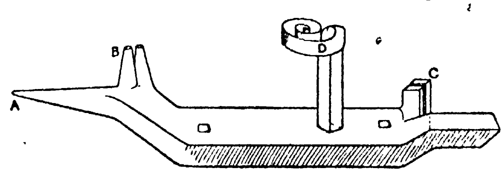
Hammer.

Shears or *snips.*

Round-nosed and square-nosed pliers.

File, 8″.

Anvil.—This may be a round weight inverted in a wooden block, but the one which best adapts itself



for all classes of bent-iron work may be obtained from the maker, Mr. C. Wiggins, Castle Ironworks, Trowbridge, price 5*s.*

Strip iron costs 9*d.* per pound, sold in widths of $\frac{1}{8}$″, $\frac{3}{16}$″, $\frac{1}{4}$″, $\frac{3}{8}$″.

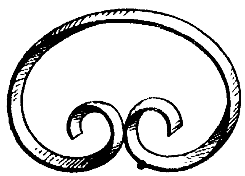
The round-nosed pliers are held in the right hand, and are used for shaping curves, whilst the square-nosed variety holds the strip firmly during the operation. If the anvil recommended above be used the curves will much more readily be obtained by means

of the scroll attachment. A dull black paint will be required for coating the completed models.

If a piece of bent-iron work be examined it will be found that the curves are usually of two forms—the C scroll and S scroll.

Cut a strip of iron, say 6″ long. Hold it firmly in the left hand about an inch from the end by means of the square-nosed pliers, and use the round-nosed variety for curling the strip from the other end, turning away the curve from the worker. Both pliers will then be brought nearer together, and the same operation will be repeated until the necessary curvature has been secured.

The strip would then be reversed, and the operation repeated from the other end, thus forming the complete C scroll. Three or four of these should be made, and may be clamped or riveted together by means of clamping or with bifurcated rivets.



This is simply a repetition of the former exercise, except that the bends are made in opposite directions. The scrolls may now be combined, either back to back or facing each other, by means of clamping or riveting.

Draw a circle, say of 4″ diameter. Adjust the strip to the circumference, allowing, say, $\frac{1}{4}$″, for overlapping. Clamp or rivet the ends to complete the circle.

By the combination of circles, scrolls, and curves a suitable framework may be completed for holding various articles.

The pupils are now sufficiently proficient in manipulating snips and pliers to attempt such exercises as are shown in illustration No. 5, Decorative Elements in Sheet Metal. Each of these designs may be cut out in thin sheet metal; an old tin opened out will do very well.

Example A.—Construct a rectangle 6″ × $\frac{1}{2}$″ on

the surface. Cut out. Divide into half-inch squares. Cut the squares across diagonals. Complete the exercise, using round-nosed pliers for rolling.

Example B is somewhat similar to the above, except that small triangular sections are cut from each base. The round-nosed pliers are again used to give the necessary curl.

In Example C the squares are cut vertically, the rolling being completed with round pliers. The decorative balls need not be attempted.

These exercises provide a very suitable training in the use of pliers. Many similar designs will suggest themselves.

The iron hinge (No. 7) could not be attempted without a forge, but if struck out in thin sheet it may be cut out as an exercise in the manipulation of shears and pliers. The rosettes may be fixed by means of rivets. Such examples as Nos. 8 and 9—

Iron Gates—might well be illustrated in bent-iron work. The rosettes in No. 9 would be made separately and fixed with bifurcated rivets (4d. per 100), the scroll being closed sufficiently to allow of the rivets passing through the rosettes.

The Grill (No. 10) would require a square foundation, which could be purchased cheaply, the remainder of the work being completed in bent iron, clamping as shown.